INTERMOUNTAIN POWER SERVICE CORPORATION

CONTRACT 04-45605

and

SPECIFICATIONS 45605

for

INDUCED DRAFT FAN MEDIUM VARIABLE FREQUENCY DRIVE SYSTEMS

CONTRACT ISSUED TO:

ALSTOM POWER CONVERSION INC.
GENERAL DRIVES
610 EPSILON DRIVE
PITTSBURGH, PA 15238-2880

CONTRACT ADMINISTRATOR: JON CHRISTENSEN

BUYER: JOHN R. LARSEN

850 West Brush Wellman Road, Delta, Utah 84624 / Telephone: (435) 864-4414 / FAX: (435) 864-6670 / Fed. I.D. #87-0388573

Contract No. 04-45605

CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT, entered into this 7th day of January, 2004, between the **INTERMOUNTAIN POWER SERVICE CORPORATION** (IPSC), a nonprofit organization under contract to the Intermountain Power Agency (IPA), a political subdivision of the state of Utah, organized and existing under the Interlocal Co-Operation Act, Title 11, Chapter 13, Utah Code Annotated 1953, as amended, and **Alstom Power Conversion Inc.**, a Corporation, with its principal office in Pittsburgh, PA, hereinafter called the (Contractor),

WHEREAS, IPSC has prepared specifications and other Contract Documents for **up to eight (8) Induced Draft (ID) Fan Medium Voltage Variable Frequency Drive Systems** as detailed in the Contract Documents (the Work), and has requested proposals from bidders to perform the Work;

WHEREAS, Contractor has submitted to IPSC a Proposal in accordance with the terms of this Contract Agreement; and

WHEREAS, IPSC has determined and declared Contractor to be the lowest and best, regular responsible bidder for the said Work, subject to execution of this Contract Agreement;

AGREEMENTS: In consideration of the compensation to be paid to Contractor, and of the mutual terms and conditions contained herein, IPSC for itself and its successors, and Contractor for itself and its permitted successors and assigns, hereby agree as follows:

ARTICLE I: Contractor shall perform in accordance with the provisions of this Contract Agreement, including the Contract Documents identified in Article III hereof.

ARTICLE II: Contractor will be paid for its performance under this Contract Agreement in accordance with the provisions of the Contract Documents, including those provisions in the Article entitled "Limitation of Liability; Responsible Party" in Part E, Division E1, General Conditions.

ARTICLE III: The term Contract Documents means and includes all of the following:

PART	DIVISION	TITLE
A	A1	Notice Inviting Proposals
B	B1	Instructions to Bidders
B	B2	Supplementary Instructions to Bidders
C		Bidding Documents
	C1	Bidder's Bond
	C1	Proposal
	C2	Proposal Schedule
	C3	Additional Bid Information
D	D1	Contract Documents Description
E	E1	General Conditions
	E2	Additional General Conditions
F		Detailed Specifications
	F1	Special Conditions
	F2	General Description and Scope of Work
	F3	General Equipment Specifications
	F4	Engineering Data
	F5	General Quality System Requirements
	F6	Seismic Design Requirements
	F7	Medium Voltage Variable Frequency Drives

Attachment 1 - Summary Bill of Material

Attachment 2 - Comments to the Specification 45605, Technical Section F2-F9

Attachment 3 - System Overview

Attachment 4 - Drive Efficiency Versus Speed

Note: For Drawings see Compact Disk

The foregoing Contract Documents, and the documents identified in Part D "Contract Documents Description," are an integral part of this Contract Agreement and are hereby

IP7011543

incorporated as part of this Contract Agreement as if fully restated herein. The above listed Contract Documents shall prevail over other information submitted with Contractor's Proposal.

ARTICLE IV: This Contract Agreement, including the Contract Documents, constitutes the entire Agreement of the parties hereto with respect to the Work and other subjects addressed herein, and supersedes all prior oral communications or written documents.

WHEREFORE, IPSC and Contractor execute this Contract Agreement as of the date stated in the first introductory paragraph.

INTERMOUNTAIN POWER SERVICE CORPORATION
850 West Brush Wellman Road
Delta, UT 84624-9546

By: George W Gross
George W. Gross
President and Chief Operations Officer

1/7/04
Date

ALSTOM POWER CONVERSION INC.
General Drives
610 Epsilon Drive
Pittsburgh, PA 15238-2880

By: Joseph C. McGrath

5-JAN-04
Date

Title: PRESIDENT & CEO

TABLE OF CONTENTS

SPECIFICATIONS

DIV	TITLE	PAGE NUMBER
A1	Notice Inviting Proposals	A1-1
B1	Instructions to Bidders	B1-1 thru B1-2
B2	Supplementary Instructions to Bidders	B2-1
	Bidding Documents	
C1	Bidder's Bond	C1-1
C1	Proposal	C1-2
C2	Proposal Schedule	C2-1 thru C2-2
C3	Additional Bid Information	C3-1 thru C3-10
D1	Contract Documents Description	D1-1
E1	General Conditions	E1-1 thru E1-9
E2	Additional General Conditions	E2-1 thru E2-2
	Detailed Specifications	
F1	Special Conditions	F1-1 thru F1-7
F2	General Description and Scope of Work	F2-1 thru F2-13
F3	General Equipment Specifications	F3-1 thru F3-10
F4	Engineering Data	F4-1 thru F4-7
F5	General Quality System Requirements	F5-1 thru F5-3
F6	Seismic Design Requirements	F6-1
F7	Medium Voltage Variable Frequency Drives	F7-1 thru F7-25

Attachment 1 - Summary Bill of Material

Attachment 2 - Comments to the Specification 45605, Technical Section F2-F9

Attachment 3 - System Overview

Attachment 4 - Drive Efficiency Versus Speed

Note: For Drawings see Compact Disk

PART A - DIVISION A1

NOTICE INVITING PROPOSALS

The Intermountain Power Service Corporation (IPSC) invites sealed bids for furnishing and delivering **up to eight (8) Induced Draft (ID) Fan Medium Voltage Frequency Drive (VFD) Systems** in accordance with **Specifications 45605**, available in the Purchasing Section, Intermountain Power Service Corporation (IPSC), 850 West Brush Wellman Road, Delta, Utah 84624-9546.

Proposals shall be submitted on IPSC's bidding forms. All Proposals shall be filed with the Buyer at the above address on or before **September 03, 2003.**

Each Proposal shall be accompanied by a certified or cashier's check payable to Intermountain Power Agency (IPA), or a Surety Bond payable to IPA, IPSC, and the City of Los Angeles Department of Water and Power (LADWP) in the amount of $50,000 as a guarantee that the bidder shall execute the proposed Contract Agreement if awarded.

Proposals shall be subject to acceptance within, and irrevocable for, a period of sixty (60) calendar days after date of bid opening.

IPSC reserves the right to reject any and all Proposals.

In the performance of any contract awarded, the bidder shall not discriminate in employment practices against any employee or applicant for employment because of race, religion, national origin, ancestry, sex, age, or physical disability.

Dated: 8/21/03

John R. Larsen, Buyer
Intermountain Power Service Corporation

PART B - DIVISION B1

INSTRUCTIONS TO BIDDERS

1. Form, Signature, and Delivery of the Proposals: The bidder's Proposal shall be made on the yellow copy of the Bidding Documents. The Specifications printed on white paper shall be retained by the bidder.

   The bidder's name, address, and the date shall be stated in the Proposal. The Proposal shall be signed by the person authorized to bind the bidder.

   The Proposal shall be enclosed in a sealed envelope, plainly marked in the upper left-hand corner with the name and address of the bidder. The envelope shall bear the words "Proposal for," followed by the Specification Number, the title of the Specifications, and the date and hour of bid opening.

   If the Proposal is mailed, it shall be addressed as follows:

   Purchasing Section
   Intermountain Power Service Corporation
   850 West Brush Wellman Road
   Delta, UT 84624-9546

   If the Proposal is sent by messenger, it shall be delivered to the Administration Building, Intermountain Power Service Corporation, 850 West Brush Wellman Road, Delta, Utah.

2. Interpretations and Addenda: Should a bidder find discrepancies or omissions in the plans, specifications, or other documents, or should there be doubt as to their true meaning, the bidder shall submit to the Buyer a written request for an interpretation or clarification thereof. A request for addenda, interpretation, or clarification shall be delivered to the Buyer marked "Request for Interpretation" and must be received by the Buyer in time to permit a reasonable response before the date of opening bids. Any interpretation of, or change in the documents will be made only by addendum issued to each person to whom Specifications have been issued and will become a part of any contract awarded. IPSC will not be responsible for, or bound, by any other explanations or interpretations.

3. Correspondence: All inquiries or correspondence to IPSC prior to award of Contract shall be addressed to the Buyer.

4. Changes or Alternatives: The bidder shall not change any wording in the documents. Any explanations or alternatives offered shall be submitted in a letter attached to the front of the Bidding Documents. Alternatives which do not substantially comply with IPSC's Specifications cannot be considered. Language of negation or limitation of any rights, remedies, or warranties provided by law will not be considered part of the Proposal. Bids offered subject to conditions or limitations may be rejected.

IP7011547

5. Specified Materials or Equivalent: Whenever any particular material or process is specified by a patent or proprietary name, by a trade or brand name, of a manufacturer, such wording is used for the purpose of describing the material or process, fixing the standard of quality required, and shall be deemed to be followed by the words "or equivalent." The bidder may offer any material or process which shall be the equivalent of that so specified, but the bidder must identify the equivalent offered.

6. Language: Everything submitted by the bidder shall be written in the English language.

7. Sales or Use Taxes: Prices quoted by the bidder shall not include any applicable sales or use taxes or Federal Excise Taxes.

8. Duties: Prices quoted by the bidder shall include all applicable duties.

9. Award of Contract: Award of Contract will be made to the lowest and best, regular responsible bidder. The determination as to which is the lowest and best, regular responsible bidder may be made on the basis of the lowest ultimate cost of the services, materials, equipment, or other Work in place and use. The right is reserved to reject any or all Proposals.

   Within thirty (30) calendar days after the date of award of Contract, Contractor shall sign the Contract supplied by IPSC as mutually agreed between the parties. The Contract will be effective upon execution by IPSC. Award of Contract is subject to execution of IPSC's form of Contract Agreement and other Contract Documents.

10. Comparison of Bids: For the purpose of comparing bids, it will be assumed that the quantity of **up to eight (8) Induced Fan Medium Voltage Variable Frequency Drive Systems** will be installed during the Contract period.

11. Bidder's Bond: The Proposal shall be accompanied by a certified check or a cashier's check issued by a responsible bank, payable in the state of Utah to the order of Intermountain Power Agency, in an amount not less than 10 percent of the aggregate sum of the Proposal. A surety bond payable to IPA, IPSC, and LADWP in a like amount will be accepted in lieu of a check.

12. Calculation of the Bonds: The estimated amount of the Proposal for the Bidder's Bond or of the Contract, will be considered to be the price, including freight charges, quoted by the bidder in the Proposal Schedule, times the assumed quantity under the Comparison of Bids in Article 10 of this Division.

IP7011548

PART B - DIVISION B2

SUPPLEMENTARY INSTRUCTIONS TO BIDDERS

1. Quantities: The Proposal shall be based on furnishing eight (8) VFD Systems in accordance with the Proposal Schedule in Division C2, Bidding Documents; however, IPSC reserves the right to reduce the quantity of VFD Systems purchased. IPSC will notify the successful bidder by the option date listed in Division C2, of the total quantity of VFD Systems required.

2. Exceptions: Bidders should note that comparison of bids shall be based upon adherence to the these Specifications and cost. Any exceptions to these Specifications are to be specifically highlighted and noted on a separate sheet of paper and submitted with the Proposal. Strict attention to any material changes or exceptions to these Specifications or commercial terms and conditions shall be taken into consideration in the bid evaluation. IPSC reserves the right to reject any or all bids.

3. Pre-Bid Job Site Visits: The existing equipment space is extremely congested with limited access. Bidders desiring to visit the IPP Job Site to verify how the proposed equipment could be moved and fit into the final mounting locations, may do so by contacting John Larsen at (435) 864-6537.

IP7011549

PART C - DIVISION C1

BIDDING DOCUMENTS

BIDDER'S BOND

(Not necessary when certified or cashier's check accompanies bid. See below*.)

SURETY BOND

We, the undersigned Principal and Surety, acknowledge ourselves jointly and severally bound to Intermountain Power Agency (IPA) and Intermountain Power Service Corporation (IPSC) of the state of Utah, and the City of Los Angeles Department of Water and Power (LADWP), in the sum of _____ Dollars ($_____), to be paid to IPA if the attached Proposal shall be accepted and the proposed Contract awarded to said bidder, and said bidder shall fail to execute the Contract and Bond for the faithful performance thereof; otherwise this obligation to be void.

Dated: _____, 20___

Firm Name: _____

_____

By: _____
(Signature)**

(Surety): _____

By: _____
(Signature)

*When the bidder is submitting a check in lieu of a Bond, the check must be made payable to Intermountain Power Agency, must either be certified by a responsible bank or be a cashier's check issued by a responsible bank, and must be payable in the state of Utah.

If check is submitted herewith, state check number 503373071 and amount $ 50,000.

**See Form, Signature, and Delivery of the Proposals, Division B1

NOTE: All signatures above must be written in ink.

Spec. 45605

PROPOSAL

The undersigned hereby proposes to furnish and deliver up to eight (8) Induced Draft Fan Medium Voltage Variable Frequency Drive Systems to the Intermountain Power Service Corporation in accordance with Specifications 45605.

The undersigned agrees, upon the acceptance of this Proposal: (a) To execute IPSC's form of Contract (including the Contract Agreement and other Contract Documents identified in said Specifications) for furnishing and delivering the items and services embraced in the accepted Proposal; and (b) To perform its obligations under the Contract at the prices stated in the accompanying Proposal Schedule.

The undersigned furthermore agrees that, in case of failure to execute such Contract Agreement and provide the necessary check or Bidder's Bond accompanying this Proposal, and the monies payable thereon, shall be forfeited to and remain the property of Intermountain Power Agency.

The undersigned declares under penalty of perjury that this Proposal is genuine, is not a sham or collusive, and is not made in the interest or in behalf of any person or entity not herein named. The undersigned further declares under penalty of perjury that the bidder has not directly or indirectly induced or solicited any other bidder to submit a sham bid, or any other person, firm, or corporation to refrain from bidding. The undersigned also declares under penalty of perjury that the bidder has not in any manner sought by collusion to secure for itself an advantage over any other bidder.

I declare under penalty of perjury under the laws of the state of Utah that the foregoing is true and correct.

Date: September 5, 2003

Bidder: ALSTOM Power Conversion

Address: 610 Epsilon Drive

Pittsburgh, PA 15238

Signed By: Gary L. Smith
(Authorized Signature)

Print Name: Gary L. Smith

Title: Deputy Director General Drives

RECEIVED
SEP 0 8 2003
PURCHASING

IP7011551

PART C - DIVISION C2

BIDDING DOCUMENTS - PROPOSAL SCHEDULE

Proposal is hereby made to furnish and deliver to IPSC **up to eight (8) Induced Draft Fan Medium Voltage Variable Frequency Drive Systems**, F.O.B., IPP Plant Site, 850 West Brush Wellman Road, Delta, UT 84624, in accordance with **Specifications 45605**, the following:

Lump Sum Price For One (1) Complete Drive System For One (1) ID Fan Delivered In January 2004	
Price in Words: Six Hundred Seven Thousand Seven Hundred Ten Dollars	Price in Dollars: $ 607,710*
Lump Sum Price For Two (2) Complete Drive Systems For Two (2) ID Fans Delivered In January 2005	
Price in Words: One Million Seventeen Thousand Four Hundred Twenty Dollars	Price in Dollars: $1,017,420*
Lump Sum Price For Three (3) Complete Drive Systems For Three (3) ID Fans Delivered In January 2006	
Price in Words: One Million Four Hundred Eighty-Six Thousand One Hundred Thirty Dollars	Price in Dollars: $1,486,130*
Lump Sum Price For Two (2) Complete Drive Systems For Two (2) ID Fans Delivered In January 2007	
Price in Words: One Million Twenty-Six Thousand Four Hundred Twenty Dollars	Price in Dollars: $1,026,420*
Sigma Synchdrive Training at Alstom's office in Pittsburgh, PA for a Maximum of Six (6) People for Four (4) Days.	
Date: To Be Determined	Price in Dollars: $ 9,250*
Latest Date for IPSC To Exercise Option To Purchase Two (2) Complete Drive Systems In January 2005	
Date: April 30, 2004	
Latest Date For IPSC To Exercise Option To Purchase Three (3) Complete Drive Systems In January 2006	
Date: February 29, 2005	
Latest Date For IPSC To Exercise Option To Purchase Two (2) Complete Drive Systems In January 2007	
Date: March 31, 2006	

***Cost includes changes agreed to through negotiation for States terminal blocks and additional training offered.**

IP7011552

Contractor's Technical Services: The following adjuring prices will be used to adjust the Contract amount for manufacturer's service representatives time:

	Daily Rate	Daily Overtime Rate
Per Diem at the IPP Job Site:	$132./hr.	$198./hr
Per Round Trip to and from the IPP Job Site:	$1200.	

Prices: The price or prices shall be firm.

Cash Terms: A discount for prompt payment is offered of _____ percent for Contract payments made within ____ calendar days after date of acceptance or delivery and receipt of invoice.

Taxes: The foregoing quoted prices are exclusive of all applicable sales and use taxes.

Manufacturer: ALSTOM Power Conversion

Location of Point of Manufacture: Pittsburgh, PA

Brand and Catalog Number or Other Designation: SYNCDRIVE

Form of Business Organization: The bidder shall state below the form of its business organization.

Bidder is: Corporation, organized under the laws of the state of Delaware.
(Corporation, Partnership, Limited Partnership, Individual)

If a partnership, the bidder shall state below the names of the partners. If a corporation, the bidder shall state below the names of the president and of the secretary.

Frank Voelker - President Joseph McGrath - Secretary

Person to Contact: Should IPSC desire information concerning this Proposal, please contact:

Name: Gary L. Smith Telephone No: 412-967-6912

Address: 610 Epsilon Drive, Pittsburgh, PA 15238

(If different, the address of bidder's chief executive office is:) _____

RECEIVED
SEP 0 8 2003
PURCHASING

PART C - DIVISION C3

BIDDING DOCUMENTS - ADDITIONAL BID INFORMATION

1. Detailed Information: The bidder shall submit complete and definitive information on its offering in sufficient detail to permit a complete analysis of the Proposal. The requirements stated in the Instructions to Bidders, relative to information submittal, shall be followed.

   The requirements for information contained in this Division are basic requirements. Additional information shall be provided as requested by IPSC.

   The blank data sheets included in this Division shall be completely filled in. The data listed therein shall not relieve Contractor of its responsibility for meeting the requirements of the Detailed Specifications.

   The bidder shall not alter the original Proposal Data Division page numbers. If it becomes necessary to add pages, other than the end of the Division, a suffix such as a, b, c, etc., shall be added to the original number to designate the added page number. Pages added at the end of the Division shall be numbered sequentially by continuation of originally established numbering.

   Where alternates are indicated in the Proposal or Proposal Data, the bidder shall provide complete information for each alternate.

2. Drawings: Drawings shall be submitted with the Proposal in sufficient detail to permit evaluation of the equipment offered and to permit preliminary arrangement studies to be made.

   A plan view drawing showing the proposed equipment in the existing electrical equipment room shall be submitted. Contractor shall also include estimated weights for all equipment. Outdoor cooling equipment, if required, shall also be shown. External interconnection one-line diagram showing all power, control, and protection cabling required to complete the installation of the VFD systems.

3. Supplementary Information: The following supplementary information has negotiated changes (see Attachments):

Supplementary Information
Complete Description of Proposed VFD. This Shall Include a Description of Shipping Components and Field Assembly Installation.
Summary Description of Codes and Standards Used If Different than Specified, Including a Review of Major Differences.

IP7011554

Supplementary Information
Identification of Any Modifications Required to IPSC's ID Fan System, Composed of ID Fan Motor, ID Fan, Connecting Shaft, Bearings, and Cable Connecting the ID Fan Motor to the VFD System to Allow this Equipment to Operate with the VFD While Maintaining a Normal Thirty (30) Year Lifetime of the ID Fan System.
Documentation Indicating Contractor's VFD System Does Not Produce Torsional Vibrations, Shaft Torsional Resonance, or Torque Pulsations Within the Connecting Shaft of the ID Fan System.
Documentation Indicating Contractor's VFD System Will Not Create Accelerated ID Fan System Bearing Wear Due to Common Mode Voltages Delivered by High Frequency PWM or Other Signals from Contractor's Inverter Drive.
Documentation Indicating Contractor's VFD System Does Not Contribute to Insulation Breakdown of the End Turns of the Motor Winding.
Names and Other Contact Information of Five (5) Purchasers of the Proposed VFD System Applied to Motors of 3,000 Horsepower (HP) and Above Who Have Had the Equipment Installed and Operating for at Least Two (2) Years.
Priced Preliminary Spare Parts List.
Input Current Including Harmonic Content at 25, 50, 75, 85, and 100 Percent Load.
Composite Data on Mean Time to Failure and Mean Time to Repair for Typical Components Contained Within the VFD System and Shown by Operating Experience to Fail or Require Replacement.
Detailed Description of the Installation Instructions of the Proposed Drive System Including All of Its Components and Any Modifications to Existing Equipment.
Description of the Failure Mode If Control Power Is Lost to the VFD Control System.
Description of VFD Operation When the Input Voltage Dips to 70 Percent.
Description of the Failure Modes of the Power Switching Devices (SCR, GTO, Diode, IGBT, IGCT, etc.), or Switching Device Control That Will Allow the Drive System to Continue to Operate Without Tripping the Fan.
Description of Accelerating and Decelerating Torque Programming Capabilities and Other Pertinent Capabilities and Limitations.
Preliminary Schedule.

Supplementary Information
Harmonic Calculation.
Efficiency (At the Input to VFD Isolation Transformer) Graph with Y-Axis Indicating 25, 50, 75, 85, and 100 Percent Torque and X-Axis Indicating 25, 50, 75, 85, and 100 Percent Frequency.
Catalog Brochures.
Complete List of Required Maintenance Tools as Discussed in Division F3, Article 15, General Equipment Specifications. The Listing Shall Include a Complete Description and Quantity of Each Item.
Information Specified in Division B1, Instructions to Bidders.
Equipment Storage Requirements, Including Inside or Outside Requirements and Requirements for Controlled Temperature or Humidity, etc.
Description of Manufacturing, Testing, and Inspection Procedures.
Written Description, Logic Diagrams, or Ladder Diagram Indicating Recommended Operating Sequence.
Maintenance Activities Required by the Manufacturer And/or by Contractor to Provide Adequate Storage and to Maintain Valid Material and Equipment Warranties.
Motor Information If Motor Is Furnished from Division F9, Medium Voltage Induction Motors.
Transformer Information Division F8, VFD Isolation (VFDI) Transformers

4. Equipment and Material Data: The following equipment and material data has negotiated changes (see Attachments):

Equipment and Material Data
Complete Description of the Proposed System Indicating Exactly What Is Being Replaced and What Is Being Reused.
A Drawing (the Plant Arrangement - AQCS Control Building Mezzanine Drawing May Be Marked up to Show Equipment Layout) Showing the Proposed Arrangement and Dimensions Including Clearances Between Existing Items and All New Items. This Drawing Shall Also Indicate the Approximate Weight of All Components and Any New Wall or Floor Penetrations.

IP7011556

Equipment and Material Data
Guaranteed Reliability and Maintainability Times of the Proposed System.
Description of the Work Required for Complete Replacement.
A List of Maintenance Tools, Which Shall Be Furnished with the Equipment.
A Description of the Manufacturer's Standard Factory Test Procedure.
Expected and Maximum Heat Loss on a per Drive Basis.
A List of at Least Three (3) Sites and Names of Individuals That May Be Contacted Where Similar Equipment Has Been Retrofitted.
If a New Motor Is Being Provided, Verify That the Minimum Speed of 10 Percent Is Acceptable to the Motor Vendor.
Since the VFD Shall Be Suitable for Continuous Operation at Turning Gear Speed for Equipment Cool-down, Provide Information Describing the Operation at Turning Gear Speed.
Harmonic Analysis, Which Includes All Voltage and Current Harmonics up to the 49th.
Any Alternate Access Options Required.
Heat Dissipation Data Necessary to Verify Adequacy of Existing HVAC System to Design a New HVAC System.
A Summary Description of Codes and Standards Used If Different than Specified Including a Review of Major Differences.
A Price List of Recommended Spare Parts.
A List of Any Special and Maintenance Tools Being Furnished.
Bidder's Experience Record with Proposed Equipment.
A List of Factory Routine Tests Being Proposed.
A Complete Description of the Extent of Shop Assembly of Components, and What Will Not Be Shop Assembled.
Efficiency Versus Load Curves Based on the Driven Equipment.

IP7011557

Equipment and Material Data
A Written Description of the Results of a Failure of Any Power Switching Device (SCR, GTO, Diode, IGBT, IGCT, etc.), or Switching Device Control. Contractor Shall Include the Sequence of Each Channel in the Write-up.
A Description of Why Rear or Side Access Is Needed.
Contractor Shall Confirm That All Power Components in the Converter Sections Will Be Mounted on a Swing Frame or Rack-out for Ease of Maintenance. If Not, Contractor Shall Describe Proposed Mounting Method.

IP7011558

Variable Frequency Drive System	
VFD Isolation Transformer Rating (kVA):	Two existing @ 4378
System Input Voltage:	6900
System Output Voltage:	3876
Rated Drive Output Power (Continuous kVA):	10,000 Hp capability i.e.
Rated Drive Output Current (Continuous A):	Approx 8,725 kVA
Nominal Load Power (HP):	7,415
Rated VFD Input Current (A):	710 A @ 6.9 kV
Nominal VFD Input Current at 8,200 HP Output (A):	583 A @ 6.9 kV
Variable Frequency Drive	
Manufacturer and Model:	ALSTOM SYNCDRIVE
Overall Dimensions:	See Drawing SAD00149, Attachment 3
Height (Inches):	
Depth (Inches):	
Width (Inches):	
Shipping Height (Inches):	
Length of Longest Shipping Piece (Inches):	
Technology:	Load Commutated Inverter
Microprocessor-Based Multi-Level Switching:	N/A
Phase/Frequency/Voltage (ph/Hz/V):	6/60/4000
Rectifier Device:	Thyristor
Inverter Device:	Thyristor
Cell Voltage (V):	3500 PIV
Number of Cells:	5 devices in series per leg

IP7011559

Variable Frequency Drive	
In the Event of Any Power Switching Device (SCR, GTO, Diode, IGBT, IGCT, etc.), Failure, Will the VFD Continue to Operate at Full Rated Output?	Yes
If "No", Explain:	
Number of Pulses:	12
DC Link Capacitors:	No
Input Power Factor (30 to 100 Percent Speed) (Cos f):	See Attachment 3
Power Interrupt Ride-Through Duration (Cycles):	Can be programmed (6 cycles typical)
Voltage Dip (With Continuous Operation) (Percent):	70% with speed loss
VFD Output Voltage (V):	3876
Overload Capability for Sixty (60) Seconds (Percent):	Power converter capable of 10,000 Hp continuous
Torque Pulsations Across Speed Range (Percent):	12 Pulse LCI
Cooling Medium:	Water/Glycol
Enclosure Protection:	Nema 1
Ambient Temperature Maximum (°C):	50
Humidity (Non-Condensing) (Percent):	95
Altitude (Feet):	4700

DC Link Reactor Data	
Manufacturer:	Existing
Class and Type of Core:	
Insulating Liquid:	
Quantity:	
Nominal DC Voltage Rating (V):	
Continuous DC Current Rating (V):	
Rated DC Load (kW):	
Conductor Material of Winding (If Aluminum, State Grade):	
Basic Lighting Impulse Insulation Level (BIL) (kV):	
Approximate Resistance at 75°C (OHM):	
Inductance (Henrys) (H):	
Loses (Guaranteed):	
No-Load Loss (Excitation Only):	
At 100 Percent Voltage (kW):	
At 110 Percent Voltage (kW):	
Total Loss, No-Load Loss Plus Load Loss, With Full Rated DC Load (kW):	
Temperature Under Continuous Operation Guaranteed:	
Temperature Rise at Full Rated DC Load:	
Winding Temperature Rise by Resistance (°C):	
Hottest Spot Winding Temperature Rise (°C):	
Average Sound Level at Rated DC Load, Scale "A", Slow Response, at One (1) Foot from Reactor (DC):	

IP7011561

DC Link Reactor Data	
Short Circuit Capability:	
DC Short Circuit Current (A):	
Maximum Duration of Short Circuit Current (Seconds):	
Weight and Dimensions:	
Net Weights:	
Core and Coils (Pound):	
Insulating Liquid (Pound/Gallon):	
Total (Pounds):	
Heaviest Piece to Handle During Erection (Pounds):	
Overall Dimensions:	
Height (Inches):	
Depth (Inches):	
Width (Inches):	
Shipping Height (Inches):	
Tuned Filter Bank	
Is a Tuned Filter Bank Required for Harmonic Suppression:	No
If "Yes", Where Is it Mounted? (Include Dimensions and Weights):	
Drive Cooling System	
Manufacturer:	Later
Cooling Methodology (Liquid/Air):	Liquid
Type of Liquid:	Water/Glycol
Is Cooling System 100 Percent Redundant:	Pumps Fully Redundant
Net Weight (Pounds):	Later

IP7011562

Harmonic Voltage Distortion			
Guaranteed Maximum Harmonic Voltage Distortion Contribution, Without Filters, to Auxiliary Electrical Power System Under the Worst Case Conditions:			
Harmonic	**90 Percent**	**100 Percent**	**110 Percent**
5	See Attachment 3		
7			
11			
13			
17			
19			
23			
25			
Total:			

Efficiency	
Guaranteed Overall System Efficiency at Rated Speed and Load (Percent):	See Attachment 4
Total Guaranteed System Losses at Rated Speed and Load (kW):	55 kW @ 7,415 Hp for VFD only
System Speed Response	
Maximum Deceleration Rate (Rpm/Sec):	~30 rpm/s
Maximum Acceleration Rate (Rpm/Sec):	~30 rpm/s
Interface	
Type and Quantity of Communication Ports Which Are Included, (i.e., RS232, RS485, USB):	See Attachment 3

PART D - DIVISION D1

CONTRACT DOCUMENTS DESCRIPTION

The Contract Agreement, together with the documents listed in Article 3 thereof, the Reference Specifications, any other documents listed below, and such of Contractor's Proposal documents as are expressly agreed to by IPSC shall constitute the Contract (the Contract). Said Documents are complementary and require complete and finished Work. Anything shown or required of Contractor in any one or more of said documents shall be as binding as if contained in all of said documents. Contractor shall not be allowed to take advantage of any error, discrepancy, omission, or ambiguity in any document, but shall immediately report to the President and Chief Operations Officer, in writing, any such matter discovered. The President and Chief Operations Officer will then decide or correct the same and the decision will be final.

IP7011564

PART E - DIVISION E1

GENERAL CONDITIONS

1. Definitions: The following words shall have the following meanings:

   a. Bidder: The person, firm, or corporation adopting and submitting a Proposal under these Specifications.

   b. Buyer: The Purchasing Agent for IPSC.

   c. Contract Administrator: The IPSC employee designated by the President and Chief Operations Officer with primary responsibility for administration of the Contract, or other representatives designated by the Contract Administrator acting within the limits of their authority.

   d. Contractor: The person, firm, or corporation to whom the Contract is awarded.

   e. Directed, Required, Approved, etc.: The words *directed, required, approved, permitted, ordered, designated, prescribed, instructed, acceptable, accepted, satisfactory,* or similar words shall refer to actions, expressions, and prerogatives of the Contract Administrator unless otherwise expressly stated.

   f. Gallon: Liquid volume of 231 cubic inches at 60 degrees Fahrenheit.

   g. IGS: Intermountain Generating Station located at 850 West Brush Wellman Road, Delta, Utah 84624.

   h. IPA: Intermountain Power Agency, the owner of Intermountain Power Project, and a political subdivision of the state of Utah, organized and existing under the Interlocal Co-operation Act, Title 11, Chapter 13, Utah Code Annotated 1953, as amended.

   i. IPP: Intermountain Power Project, consisting of Intermountain Generating Station, Intermountain Railcar, Intermountain Converter Station, Adelanto Converter Station, Intermountain AC Switchyard and associated transmission lines, microwave stations, and support facilities.

   j. IPSC: Intermountain Power Service Corporation, a nonprofit corporation, furnishing personnel to support the Operating Agent in the performance of operation and maintenance.

   k. Operating Agent, or LADWP: The City of Los Angeles Department of Water and Power which is responsible for operation and maintenance for IPP.

l. President and Chief Operations Officer: The President and Chief Operations Officer of IPSC, or other representatives designated by the President and Chief Operations Officer acting within the limits of their authority.

m. Reference Specifications: Those bulletins, standards, rules, methods of analysis or tests, codes, and specifications of other agencies, engineering societies, or industrial associations referred to in these Specifications. These refer to the latest edition, including amendments published and in effect at the date of the Invitation for Proposal, unless specifically referred to by edition, volume, or date. Unless the context otherwise requires, Reference Specifications also include all amendments published or adopted after the date of the Invitation for Proposal.

n. Subcontractor: A person, firm, or corporation, other than Contractor and employees thereof, who supplies labor, services or materials for a portion of the Work to be performed by Contractor under the Contract.

o. Ton: The short ton of 2,000 pounds.

p. Work: The services, materials, equipment, and other performance identified in these Specifications and other Contract Documents to be provided by Contractor.

2. Materials and Work: All materials and Work shall comply with these Specifications. All materials and equipment furnished shall be new and unused, but this requirement shall not preclude the use of recycled materials in the manufacturing processes. All Work shall be done by qualified workers in a thorough and workmanlike manner. Materials or workmanship not definitely specified, but incidental to and necessary for the Work, shall conform to the best commercial practice for the type of Work in question.

3. Nondiscrimination: The applicable provisions of Executive Order No. 11246 of September 24, 1965, and Bureau of Land Management regulations, and all other applicable governmental regulations pertaining to nondiscrimination in employment in the performance of contracts, are incorporated herein by reference, and made a part hereof as if they were fully set forth herein. During the performance of the Contract, Contractor shall not discriminate in its employment practices against any employee or applicant for employment because of the employee's or applicant's race, religion, national origin, ancestry, sex, age, or physical disability. All subcontracts awarded under or pursuant to the Contract shall contain a like nondiscrimination provision.

4. Governing Law; Venue: The Contract shall be governed by the substantive laws of the state of Utah, regardless of any rules on conflicts of laws or choice of law that would otherwise cause a court to apply the laws of any other state or jurisdiction. Any action,

IP7011566

in law or in equity, concerning any alleged breach of or interpretation of the Contract, or concerning any tort in relation to the Contract or incidental to performance under the Contract, shall be filed only in the state or federal courts located in the state of Utah.

5. Patents and Intellectual Property: Contractor shall fully indemnify and defend IPA, IPSC, and the Operating Agent against any and all liability, whatsoever, by reason of any alleged infringement of any intellectual property rights including, but not limited to, patents, copyrights, trademarks, or trade secrets on any article, process, method, or application used in the construction of the Work, or by reason of use by IPSC of any article or material furnished under the Contract. In case of infringement of any third party intellectual property Contractor shall, at its own expense, subject to the provisions of this clause, either procure for such indemnified party an irrevocable, royalty-free license to continue using such article, process, method or application, or, provide substantially equal but non-infringing articles or modify such infringing article, process or method of application so that they become non-infringing, provided that no such replacement or modification shall in any way amend or relieve Contractor of its warranties and guarantees set forth in the Contract.

   In the event of any claim being made or action brought against IPSC arising out of matters referred to in this clause, Contractor shall be promptly notified and may, at Contractor's own expense, conduct all negotiations for the settlement of the same and any litigation that may arise therefrom.

6. Contractor's Address and Legal Service: The address given in the Proposal shall be considered the legal address of Contractor and shall be changed only by advance written notice to IPSC. Contractor shall supply an address to which certified mail can be delivered. The delivery of any written communication to Contractor personally, or delivery to such address, or the depositing in the United States Mail, registered or certified with postage prepaid addressed to Contractor at such address, shall constitute a legal service thereof.

7. Assignment of Contract Prohibited: Neither party shall assign or otherwise attempt to dispose of the Contract, or of any of the monies due or to become due thereunder, unless authorized by the prior written consent of the President and Chief Operations Officer and Contractor, such authorization not to be unreasonably withheld. No right can be asserted against IPA, IPSC, or the Operating Agent, in law or equity, by reason of any assignment or disposition unless so authorized.

   If either party, without such prior written consent, purports to assign or dispose of the Contract or of any interest therein, the other party, at its option, may terminate the Contract, and shall be relieved and discharged from any and all liability and obligations to the party in non-compliance with the requirements hereof, and to any assignee or transferee thereof. Such termination shall not waive or relieve either party's obligations to make payments due hereunder for Work performed.

8. Quality Assurance: IPSC has the right to subject any or all materials, services, equipment, or other Work furnished and delivered under the Contract to rigorous inspection and testing. (Unless otherwise specifically provided in the Contract with respect to specific materials, services, equipment, or other Work, IPSC has no duty to inspect, test, or specifically accept.) Before offering any material, services, equipment, or other Work for inspection, testing, delivery, or acceptance, Contractor shall eliminate all items or portions which are defective or do not meet the requirements of these Specifications. If any items or portions are found not to meet the requirements of these Specifications, the lot, or any faulty portion thereof, may be rejected. Only the Contract Administrator may accept any material, service, equipment, or other Work as complying with these Specifications on behalf of IPSC.

IPSC may inspect and reject materials, services, equipment, or other Work tendered or purchased under the Contract at any reasonable location IPSC may choose (including, but not limited to, points of origin, while in transit to IPSC, IPSC specified receiving points, IPSC storage sites, or any point of use or installation). Inspection can include any testing that IPSC deems necessary or convenient to determine compliance with these Specifications. The expense of any initial tests will be borne by IPSC. All expenses of subsequent or additional tests will be charged against Contractor when due to failure of first-offered materials, services, equipment, or other Work to comply with these Specifications.

The fact that the materials, services, equipment, or other Work have or have not been inspected, tested, or accepted by IPSC, whether voluntarily or as required by any specific provision in the Contract, shall not relieve Contractor of responsibility in case of later discovery of nonconformity, flaws, or defects, whether patent or latent.

9. Extra Work, Reduced Work, and Change Orders by IPSC: IPSC reserves the right at any time before final acceptance of the entire Work to request Contractor to perform extra Work, furnish extra material or equipment, or to make changes altering, adding to, or deducting from the Work, without invalidating the Contract. Changes shall not be binding upon either IPSC or Contractor unless made in writing in accordance with this Article.

Changes will originate with the President and Chief Operations Officer who will transmit to Contractor a written request for a Proposal covering the requested change, setting forth the Work in detail, and including any required supplemental plans or specifications. Upon receipt of such request, Contractor shall promptly submit in writing to the President and Chief Operations Officer a Proposal offering to perform such change, a request for any required extension of time caused by such change, and an itemized statement of the cost or credit for the proposed change. Failure of Contractor to include a request for extension of time in the Proposal shall constitute conclusive evidence that such extra Work or revisions will entail no delay and that no extension of time will be required.

IP7011568

If Contractor's Proposal is accepted by IPSC, a written change order will be issued by the President and Chief Operation's Officer stating that the extra Work or change is authorized and granting any required adjustments of Contract price and of time of completion.

Additional Work or changes pursuant to the change order shall be performed in accordance with the terms and conditions of these Specifications. No extra Work shall be performed or change made unless pursuant to such written change order, and no claim for an addition to the Contract price shall be valid unless so ordered.

Notwithstanding anything in the preceding paragraphs to this Article, IPSC may issue a written order reducing the Scope of Work without issuing a request for Proposal. Any such reduction in the Scope of Work shall be effective upon issuance. Reductions ordered by IPSC shall constitute partial terminations and shall reduce the Contract price to be paid.

10. Changes at Request of Contractor: Changes may be made to facilitate the Work of Contractor if Contractor requests a change for reasons other than as a result of unforeseeable conditions or as a result of delays due to Work of IPSC or others under IPSC's control, then such changes may only be made without additional cost to IPSC and without extension of time. Permission for such changes shall be requested in writing by Contractor to the President and Chief Operations Officer. If changes are required by Contractor as a result of unforeseeable conditions or delays due to Work of IPSC or others under IPSC's control, Contractor shall promptly advise IPSC of such need for change and the parties shall agree upon an equitable adjustment in the Contract price and schedule as may be necessary to overcome the effect of such change.

11. Schedule and Extensions of Time: Delivery shall be completed within the times and by the dates specified. Time for delivery shall not be extended except as provided in this Article and Part F, Division F1, Detailed Specifications - Special Conditions, Article 13, Force Majeure.

If Contractor makes a timely written request in accordance with this Article, the time for delivery and Contract price for the Work will be extended/increased as necessary to overcome the effect of such delay in the Work which is: (a) authorized in writing by the President and Chief Operations Officer; or (b) to the extent caused by IPSC or others under its control, or (c) due to unforeseeable causes (such as war, strikes, or natural disasters) and which delay is beyond the control and without the fault or negligence of Contractor and subcontractors.

Contractor shall promptly notify the President and Chief Operations Officer in writing when Contractor could have been reasonably expected to recognize that such delay has occurred, of its cause, its effect on the whole Work, and the extension of time and, to

IP7011569

the extent a delay is attributable to IPA, IPSC, or the Operating Agent or others under its control the increase in the Contract price claimed. Failure of Contractor to provide such written notices prior to final payment and to show such facts shall constitute conclusive evidence that no excusable delay has occurred and that no extension of time is/was required. The President and Chief Operations Officer will ascertain the facts and the extent of the delay and will extend the time for delivery when the findings of fact justify such an extension. The President and Chief Operations Officer's determination will be final subject to Contractor's right to protest the decision as stated in Part E, Division E1, General Conditions, Article 12, Protests and Claims.

In the event of a delay in delivery which is attributable to the fault of Contractor (which for the avoidance of doubt shall include delay attributable to Contractor's subcontractors and subsuppliers) then Contractor shall pay liquidated damages to IPSC in accordance with the liquidated damages provided by Part F, Division F1, Special Conditions, Article 17, Liquidated Damages. Liquidated damages payable under the Contract shall be paid by Contractor in full and final satisfaction of Contractor's liability and as IPA's, IPSC's, and the Operating Agent's sole remedy for the act or default for which they are payable.

IPSC will be responsible for granting extensions of time as herein provided, but will not otherwise be responsible in any manner or liable to any extent for damage directly or indirectly suffered by Contractor as a result of any delay.

12. Protests and Claims: If Contractor considers any demand of the President and Chief Operations Officer to be outside of the requirements of the Contract, or considers any amount of payment, or any record, ruling, or other act, omission, or determination by the President and Chief Operations Officer to be unreasonable, Contractor shall promptly deliver to the President and Chief Operations Officer a written statement of the protest and of the amount of compensation or nature of accommodation, if any, claimed.

Upon written request by the President and Chief Operations Officer, Contractor shall provide documentation and records of evidence relating to the protest or claim.

Upon review of the protest, claim, and evidence, the President and Chief Operations Officer will promptly advise Contractor in writing of the final decision which will be binding on all parties from Contractor subject to Contractor's right to seek remedy in courts having jurisdiction over the Contract, provided that Contractor shall have advised IPSC of its intent to seek such legal remedy within thirty (30) calendar days of any such final decision by the President and Chief Operations Officer on behalf of IPSC.

13. Limitation of Liability: It is understood and agreed that IPA shall be the sole party or person liable to Contractor for payments under or pursuant to the Contract, and for any breaches, defaults, or for any torts in the performance of or in relation to the Contract by IPA, IPSC, or the Operating Agent, or any officers, agents, or employees thereof.

Contractor hereby expressly covenants and agrees that no suit shall be brought by Contractor against IPSC, or the Operating Agent, or their, or IPA's officers, agents, or employees, or any of the purchasers of power from IPA, but that all rights or remedies that Contractor may have or that may arise under or in relation to the Contract shall be asserted by Contractor solely against IPA. Without limiting the foregoing provisions of this Article, Contractor shall have no right against any of the foregoing (including IPA) to assert or recover, in contract or in tort, damages or losses in the nature of consequential damages, incidental damages, indirect damages, and special damages, or punitive or exemplary damages.

IPSC expressly agrees that Contractor and its affiliated companies' aggregate liability to IPA, IPSC, and the Operating Agent on all claims of any kind, whether based on Contract warrant, tort (including negligence), strict liability, or otherwise, for all losses or damages arising out of, connected with or resulting from, the Contract, its performance or breach (including indemnity, warranty, and any liquidated damages) shall not exceed the Contract price. No action, regardless of form, arising out of the transactions under the Contract may be brought by IPA, IPSC, or the Operating Agent more than one (1) year after discovery.

IN NO EVENT, WHETHER AS A RESULT OF BREACH OF CONTRACT, INDEMNITY, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, PROFESSIONAL LIABILITY, PRODUCTS LIABILITY, CONTRIBUTION OR OTHERWISE, SHALL CONTRACTOR OR AFFILIATED COMPANIES BE LIABLE TO IPA, IPSC, OR THE OPERATING AGENT IN EXCESS OF THE CONTRACT PRICE FOR INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHETHER IN OR ON ACCOUNT OF FAILURE OF REMEDY OR OTHERWISE, INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR REVENUE; LOSS OF DATA; LOSS OF USE OF EQUIPMENT OR TECHNOLOGY; DAMAGE TO OTHER TANGIBLE PROPERTY OF IPA, IPSC, OR THE OPERATING AGENT; COST OF CAPITAL; COST OF SUBSTITUTE EQUIPMENT, SERVICES, OR FACILITIES; DOWNTIME COSTS; COST OF REPLACEMENT STEAM OR ELECTRIC POWER OR CLAIMS OF CUSTOMERS OR THIRD PARTIES FOR SERVICE INTERRUPTIONS; DELAYS OR CLAIMS OF CUSTOMERS OR THIRD PARTIES FOR SUCH DAMAGES, PROVIDED THAT FOR PURPOSES OF THIS CLAUSE, DIRECT DAMAGES TO IPA'S, IPSC'S, OR THE OPERATING AGENT'S PROPERTY CAUSED BY CONTRACTOR'S NEGLIGENCE OR AS A RESULT OF PRODUCT LIABILITY SHALL NOT BE CONSTRUED AS INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Subject to Contractor's limitation of liability as set forth above, Contractor shall at all times, take adequate precautions to protect IPA's, IPSC's, and the Operating Agent's property. Contractor shall, at its option and taking into account IPSC's need to operate, repair, replace, or reimburse IPA, IPSC, and the Operating Agent for any damage to equipment or property of IPA, IPSC, and the Operating Agent to the extent arising out of

Contractor's negligent acts or omissions or that may arise as a result of Contractor's product liability.

The limitation of Contractor's liability and exclusion of indirect, special, incidental, or consequential damages, as provided for in paragraphs above, shall prevail over any conflicting or inconsistent provisions contained in any of the documents comprising the Contract, but shall not limit or restrict any appreciable damages.

14. Independent Contractor: Contractor shall perform all Work as an independent contractor in the pursuit of its independent calling. Contractor is not an employee, agent, joint venturer, partner, or other representative of IPA, IPSC, or the Operating Agent and shall be under the control of IPSC only to provide the Work requested and not as to the means or manner by which the Work is to be accomplished. Contractor has no authority to act for, bind, or legally commit IPA, IPSC, or the Operating Agent in any way.

15. Drug Policy: Contractor shall submit a current copy of its drug policy for review. IPP Facilities are a drug free and zero tolerance workplace. Contractor's employees and its subcontractors' employees, who are to perform Work or otherwise be at the IPP Facilities, shall participate in a drug testing program prior to arrival, and at any additional time(s) during the Contract as IPSC may request.

16. Security and Safety Compliance: Contractor and its employees, agents, representatives, and/or subcontractors, while performing Work on IPP premises, or who are otherwise on IPP premises, shall fully comply with all security, fire prevention, and safety rules and procedures in force at IPP. IPSC has the right (but not duty) to make periodic and random inspections of the persons, and of their respective property, upon entering, at any time while on, and when departing any IPP facility. Such persons subject to inspection include Contractor, any subcontractor, and their respective employees, agents, and representatives. Property subject to inspection includes, but is not limited to, vehicles, clothing, toolboxes, lunch boxes, any other carrying case, tools or equipment, and anything contained therein. If violations are noted, the violations will be reported to Contractor's on-site supervisor and the Contract Administrator for appropriate action.

All Contractor's employees will be given security identification badges by IPSC and those badges shall be displayed each day to allow admittance on IPP premises. Contractor's employees who do not have security identification badges in their possession, will not be allowed on the IPP Job Site unless signed in by the Contract Administrator. All security identification badges shall be returned to the Security Contractor when the employee terminates their work at the IPP Job Site. All Contractor's vehicles will also receive parking stickers from the Security Contractor allowing entrance on IPP Premises. Temporary badges and parking stickers are available for intermittent Contractor employees and vehicles.

Contractor shall have access on IPP premises between the hours of 7:00 am to 7:00 pm Monday through Friday. Access may be allowed on weekends or at other times with the approval of the Contract Administrator.

Contractor will be directed to specified areas for parking vehicles and equipment by the Contract Administrator. Certain areas of IPP premises are restricted to IPSC vehicles only. Exceptions to the parking restriction will be made on an as needed basis through Contractor's respective Contract Administrator. Contractor shall make its employees, agents, representatives, and/or subcontractors aware of all areas that are subject to restricted parking.

Contractor agrees, warrants, and represents that: (a) It is familiar with the risks of injury associated with the Work and otherwise being on IPP Premises; (b) Has reviewed the Work to be performed; (c) Has inspected the IPP Job Site with an IPSC representative, and (d) has determined that no unusual or peculiar risk of harm exists with regard to the Work to be performed on IPP Premises. Contractor further agrees that it shall, at all times, provide on IPP premises, a competent supervisor(s) familiar with IPSC's and the industry's safety standards to ensure compliance with all federal, state, and local regulations pertaining to safety (including, but not limited to, Federal and State OSHA, as said regulations relate to the Work to be performed under the Contract). Although IPSC assumes no responsibility to oversee or supervise the Work, IPSC reserves the right to review safety programs and practices and to make recommendations to Contractor. No such review or recommendation by IPSC shall impose any liability or responsibility on IPSC, or relieve Contractor from providing a safe working environment and complying with all legal requirements.

Contractor shall comply with IPSC's safety and equipment requirements prior to starting the Work. Worker protective clothing, which includes, but is not limited to, hardhats, safety glasses, safety shoes, gloves, respirators, earplugs, safety harnesses, and face shields shall be provided by Contractor.

Prior to starting the Work, all of Contractor's personnel shall attend a safety orientation taught by a representative of IPSC. At Contractor's option and subject to IPSC approval, a supervisor of Contractor may attend the orientation taught by IPSC, and then present the orientation to the remainder of Contractor's personnel. In that case, a roll shall be provided to IPSC which lists each person who received the orientation and the date it was received.

17. Nonexclusive: This is a nonexclusive Contract. IPSC reserves the right to obtain services, materials, equipment, or other Work from other vendors or suppliers.

PART E - DIVISION E2

ADDITIONAL GENERAL CONDITIONS

1. Equipment Warranty: Contractor warrants that the Equipment supplied by Contractor will be of the kind and quality specified in the Contract and will be free of defects in workmanship and material. In the event any Equipment fails to comply with this warranty, and IPSC notified Contractor promptly in writing of such nonconformity within twelve (12) months from the date of installation (the "Equipment Warranty Period"), Contractor shall correct such nonconformity, at its option, by repair or replacement of defective part(s) F.O.B. point of installation. If Contractor has installed or provided Technical Assistance with respect to the Equipment, the Equipment Warranty Period shall be twelve (12) months from the date the Equipment is initially placed into operation or eighteen (18) months from the date of last major shipment, whichever occurs first.

   a. Warranty Conditions: The warranties and remedies set forth in this Article are conditioned upon: (a) IPSC's receipt, handling, storage, and maintenance of Work in accordance with documentation and written procedures provided by Contractor. In addition, such Work shall not have been operated in excess of limitations specified in writing by Contractor (which limitations shall not be in derogation of the other terms of these Specifications) and not have been subjected to accident, alteration, abuse, or misuse; and (b) IPSC shall provide diagnosis and working access to the nonconformity based on availability of equipment due to plant operating constraints. Contractor shall be responsible for all costs in determining the cause of failure and repair or replacement of the failed component(s)

   b. Exclusivity of Warranties and Remedies: THE WARRANTIES IN THIS ARTICLE ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER STATUTORY, EXPRESS OR IMPLIED (INCLUDING ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE AND ALL WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE). The remedies provided herein are IPSC's exclusive remedies for any failure of Contractor to comply with its Contract Agreement obligations. Correction of any defect or nonconformity in the manner and for the period of time provided above shall constitute complete fulfillment of all such liabilities of Contractor whether the claims of IPSC are based in contract, tort (including negligence), strict liability and alternative tort remedies or any other theory of law with respect to or arising out of the Work furnished or performed hereunder.

2. Payment: Payment will be made within thirty (30) calendar days after delivery and receipt of the invoice as reasonably requested by IPSC.

   Overdue payments are subject to a late charge, calculated from the date of invoice to the date of payment, equal to the lesser of 1 percent per month or the highest applicable rate allowed by law.

If payment is not made within thirty (30) calendar days of the date of any invoice becoming due and payable, Contractor shall be entitled to give written notice to IPA and IPSC requiring payment. If without valid cause under the terms of the Contract, IPSC fails to make payment within fourteen (14) calendar days after receipt of such notice, then Contractor shall be entitled to suspend performance of the Work and to obtain an extension of time and cost as a result of such.

Progress payments will be made in accordance with the payment scheduled detailed in the Contract Documents.

3. Invoices: Invoices shall be submitted in duplicate to Accounts Payable, Intermountain Power Service Corporation, 850 West Brush Wellman Road, Delta, Utah 84624-9546. All letters pertaining to invoices shall be addressed to the foregoing address.

   All invoices shall show the Contract number, release number, or other identification of each delivery covered by the invoice. In all cases, the amount of the applicable sales tax or use tax shall be separately stated on the invoice.

4. Regulations, Permits, Licenses, and Warrants: Contractor shall comply with all applicable federal, state, and local regulations including, but not limited to, Federal and State OSHA, as said regulations relate to the Contract, Contractor's performance, or Contractor's trade. In addition, Contractor shall ensure that all permits, licenses, and warrants relating to the Contract, Contractor's performance, and Contractor's trade be acquired.

5. Letters to IPSC: All inquiries relating to these Specifications prior to award of Contract shall be addressed to the Buyer.

   After award of Contract, all letters pertaining to performance of the Contract (other than invoice) shall be addressed as follows:

   Mr. George W. Cross
   President and Chief Operations Officer
   Intermountain Power Service Corporation
   850 West Brush Wellman Road
   Delta, UT 84624-9546

   Attention: Jon Christensen,
   Contract Administrator

   Regarding Contract No. **04-45605**

PART F - DIVISION F1

DETAILED SPECIFICATIONS - SPECIAL CONDITIONS

1. General: Under the terms of the Contract, Contractor shall furnish and deliver **up to eight (8) Induced Draft Fan Medium Voltage Variable Frequency Drive Systems** ordered by IPSC during the period of four (4) years beginning with date stated in the first introductory paragraph of the Contract Agreement (hereinafter called the Contractual Period).

2. Quantity: IPSC agrees to purchase **up to eight (8) Induced Draft Fan Medium Voltage Variable Frequency Drive Systems** during the Contractual Period.

   In consideration of the above agreed purchase quantity, IPSC will, during the Contractual Period, have the option (but not duty) to purchase **Induced Draft Fan Medium Voltage Variable Frequency Drive Systems** up to a quantity of eight (8). Said option may be exercised, in whole or in part, by the issuance to Contractor of releases for any portion thereof by the Buyer or the Buyer's duly authorized representative. Nothing contained herein shall require IPSC to order any of its requirements beyond the quantities stated in Division A1 from Contractor as opposed to from other suppliers or contractors.

3. Delivery: Contractor shall make deliveries only upon receipt of releases issued by the Buyer. IPSC reserves the right to specify in said releases the amounts and dates of deliveries at the location described in the Proposal Schedule. IPSC will require ID fans to be delivered as indicated in Division F2, Article 15, Schedule of Activities, in the table titled, Equipment to be Delivered to the Job Site.

   Deliveries shall be made between the hours of 8:00 a.m and 3:00 p.m., except holidays, Monday through Friday, unless other arrangements are made in writing between Contractor and Buyer.

4. Printed Documents: All printed documents, including drawings and instruction books, if applicable, shall be in the English language. All units of measurement shall be in the English foot-pound-second system.

5. Delivery Arrangements: After award of the Contract and prior to delivery or other performance of any Work, Contractor shall become familiar with the unloading facilities at the delivery point(s) set forth in the Proposal Schedule, either by personal inspection or by contacting the Contract Administrator, (435) 864-4414.

6. Indemnity Clause: To the extent of its negligence or other legal fault, Contractor undertakes and agrees to indemnify, hold harmless, and at the option of IPA, defend IPA, IPSC, LADWP, and any and all of their boards, officers, agents, representative, employees, assigns and successors in interest (to the extent that Contractor has agreed to such assigns and successors in accordance with the provisions of the Contract)

(hereinafter "Indemnified Parties") from and against any and all suits and causes of action, claims, charges, costs, damages, demands, expenses (including, but not limited to, attorneys' fees and cost of liligation), judgments, civil fines and penalties, liabilities or losses, related to violation of laws and regulations, the death, bodily injury or personal injury to any person, including Contractor's employees and agents, or damage or destruction, to any third party tangible property in any manner arising by reason of or incident to the performance of the Contract on the part of Contractor or Contractor's officers, agents, employees, or subcontractors of any tier. The obligation of Contractor to indemnify Indemnified Parties is conditioned on the Indemnified Parties giving Contractor prompt notice of any loss, damage, or claim, and providing Contractor a full opportunity to takeover, defend, and reasonably approve any settlement thereof.

It is the intent of the parties hereto that, where fault, acts, or omissions are determined to be contributory, principles of comparative negligence will be followed and each part shall bear the proportionate cost of any loss, damage, expense, and liability attributable to that party's negligent acts or omissions.

7. Insurance Requirements: Prior to the start of the Work, Contractor shall furnish IPSC evidence of coverage from insurers authorized to do business in the state in which Work will be performed. Such insurance shall be maintained by Contractor at Contractor's sole cost and expense.

Should any portion of the required insurance be on a "Claims Made" policy, Contractor shall, prior to the policy expiration date following completion of the Work, provide evidence that the "Claims Made" policy has been renewed or replaced with the same limits, terms and conditions of the expiring policy, or that an extended discovery period has been purchased on the expiring policy at least for the Contract under which the Work was performed.

Contractor shall be responsible for all subcontractors' compliance with these insurance requirements.

a. Workers' Compensation/Employer's Liability: Workers' Compensation Insurance covering all of Contractor's employees in accordance with the laws of all states in which the Work is to be performed and including Employer's Liability Insurance, and as appropriate, Broad Form All States Endorsement, Voluntary Compensation, Longshoremen's and Harbor Workers' Compensation, Jones Act, and Outer-Continental Shelf coverages. The limit for Employer's Liability coverage shall be not less than $1 million each accident and shall be a separate policy if not included with Workers' Compensation coverage. Evidence of such insurance shall be in a form acceptable to IPSC and providing for a thirty (30) calendar days prior written notice of cancellation or non-renewal of a continuous policy to IPSC, by receipted delivery, and a Waiver of Subrogation in favor of IPA, IPSC, and LADWP, its officers, agents, and employees with regard to Workers' Compensation/Employer's Liability only. Workers'

IP7011577

Compensation/Employer's Liability exposure may be self-insured provided that IPSC is furnished with a copy of the certificate issued by the state authorizing Contractor to self-insure. Contractor shall notify IPSC, by receipted delivery, as soon as possible of the state withdrawing authority to self-insure.

b. Comprehensive General Liability: Comprehensive General Liability with Blanket Contractual Liability, Products and Completed Operations, Broad Form Property Damage, Premises and Operations, Independent Contractors, and Personal Injury coverages included. Such insurance shall provide coverage of $5 million Combined Single Limit per occurrence and in the aggregate. Umbrella or Excess Liability coverages may be used to supplement primary coverages to meet the required limits. Evidence of such coverages shall be in a form acceptable to IPSC and provide for the following:

(1) To include IPA, IPSC, LADWP, and their officers, agents, and employees as additional insured with the Named Insured to the extent of Contractor's indemnity obligations assumed under the Contract.

(2) That the insurance is primary and not contributing with any other insurance maintained by IPA, IPSC, or LADWP.

(3) A Severability-of-Interest or Cross-Liability Clause such as: "The policy to which this endorsement is attached shall apply separately to each insured against whom a claim is made or suit is brought, except with respect to the limits of the company's liability."

(4) That the policy shall not be subject to cancellation, change in coverage, reduction of limits or nonrenewal of a continuous policy, except after written notice to IPSC, by receipted delivery, no less than thirty (30) calendar days prior to the effective date thereof.

(5) A description of the coverages included under the policy.

c. Comprehensive Automobile Liability: Comprehensive Automobile Liability covering the use of owned, nonowned, hired, and leased vehicles for limits of $1 million Combined Single Limit per occurrence and in the aggregate. Such insurance shall include Contractual Liability coverage. Policy provisions for additional insureds, primary insurance, Severability-of-Interest, and cancellation shall be the same as described above in the Comprehensive General Liability, subarticle b. The Comprehensive Automobile Liability coverage may be included with the Comprehensive General Liability coverage.

d. Professional Liability: Contractor shall provide Professional Liability Insurance with Contractual Liability coverage included, covering Contractor's liability arising from errors and omissions made directly or indirectly during the execution and

IP7011578

performance of the Contract and shall provide coverage of $5 million Combined Single Limit. Evidence of such insurance shall be in the form of a special endorsement of insurance and shall include a Waiver of Subrogation against IPA, IPSC, and LADWP, their officers, agents, and employees.

The policy shall not be subject to cancellation, change in coverage, reduction of limits, or nonrenewal of a continuous policy, except after written notice to IPSC, by receipted delivery, not less than thirty (30) calendar days prior to the effective date thereof.

e. Other Conditions:

(1) Failure to maintain and provide acceptable evidence of any of the required insurance for the required period of coverage shall constitute a major breach of Contract, upon which IPSC may immediately terminate or suspend the Contract. In addition or in the alternative, IPSC has the right (but not duty), to procure such insurance and: (a) To deduct the cost thereof from any monies due Contractor under the Contract or otherwise; and/or (b) To charge and collect the cost thereof from Contractor, payable upon demand. Such claim, deduction, or charge shall include an administrative fee of two (2) percent of the cost of procuring said insurance. Said insurance may be procured and maintained in the name of Contractor, IPA, IPSC, LADWP, and/or any combination thereof, as primary and/or secondary insured, all as IPSC may from time to time elect.

(2) Contractor shall be responsible for all subcontractors' compliance with these insurance requirements. The foregoing remedies in subsection (1) shall be available to IPSC against Contractor for any failure by any subcontractor to maintain and provide the required insurance.

8. Transportation: All shipments of hazardous materials under the Contract or in connection herewith shall be handled in accordance with current U.S. Department of Transportation regulations and all other applicable federal, state, and local laws and regulations.

9. Material Safety Data Sheets: Contractor shall furnish IPSC with a Material Safety Data Sheet (MSDS) for all hazardous materials furnished under the Contract, used, stored, or transported on or near IPP premises in connection with the Contract. The MSDS shall be furnished to IPSC on, or prior to, the date of the first delivery, use, storage, or transportation of the materials or equipment. If these Specifications require that Contractor furnish instruction books, the MSDS shall also be included in such books.

IP7011579

10. Contract Termination:

a. For Convenience or Security: IPSC reserves the right, by giving twenty (20) calendar days prior written notice (or such longer notice as IPSC may select) to Contractor, to terminate the whole or any part of the Contract at IPSC's convenience, whether or not Contractor is in default. IPSC also reserves the right to terminate the Contract, effective immediately upon notice, for purposes of security or safety of IPP Facilities, persons who work at IPP Facilities, or the public. In the event of termination for convenience, security, or safety, IPA will pay Contractor reasonable and proper direct costs of termination (if, however, Contractor's Proposal includes cancellation charges, payment for termination costs shall not exceed the cancellation charges set forth therein). Contractor shall, after consultation with IPSC, take all reasonable steps to minimize the costs related to termination. Contractor shall provide IPSC with an accounting of costs claimed, including adequate supporting information and documentation and IPSC may, at its expense, audit the claimed costs and supporting information and documentation.

b. For Breach: IPSC may terminate the whole or any part of the Contract effective immediately upon notice, in the event Contractor is in material default, and without right on the part of Contractor to claim any termination costs. This right to terminate is in addition to, and not in lieu of, any other remedy provided in the Contract or otherwise provided by law or equity.

c. Limitation of Liability: In no event shall termination of this Contract, or any portion thereof, whether for convenience, security, safety, breach, or otherwise, constitute the basis for or result in any claim by Contractor for consequential or incidental damages (including loss of anticipated profits or other economic damages) or punitive damages, and Contractor hereby releases IPA, IPSC, and LADWP, and their officers, directors, employees, agents, and representatives, from any and all such claims or liability.

11. Suspension of Work: IPSC reserves the right to suspend and reinstate execution of the whole or any part of the Contract and the Work without invalidating the provisions of the Contract. In the event the Work is suspended, Contractor will be reimbursed for actual direct unavoidable costs that it reasonably incurs as a result of the suspension. Claims for such cost reimbursement shall be submitted by invoice. Contractor shall use all reasonable means to minimize such costs, and shall allow IPSC to audit costs claimed. Contractor shall, upon request by IPSC, provide a projection of costs it anticipates to incur during any suspension, or continuation of suspension, contemplated by IPSC. In no event shall suspension constitute the basis for, or result in, any claim for consequential or incidental damages (including loss of anticipated profits or other economic damages) or punitive damages, and Contractor hereby releases IPA, IPSC, and LADWP, and their officers, directors, employees, agents, and representatives, from any and all such claims or liability.

12. No Waiver: No breach, noncompliance, or other failure to perform (collectively "breach") by Contractor, or any subcontractor, or of any Work shall be deemed waived unless expressly waived in writing by the President and Chief Operations Officer. No waiver by IPSC of any one breach shall be deemed to waive any other prior, concurrent, or subsequent breach. No exercise, or failure to exercise, or delay in exercising any particular remedy by IPSC shall be deemed a waiver or preclude IPSC from subsequently invoking that remedy for that breach or any other breach. All remedies granted to IPSC in the Contract, or by law or equity, are cumulative and may be exercised in any combination or order.

13. Force Majeure: Contractor shall be entitled to an equitable extension of time in the event of a delay beyond its reasonable control (including, without limitation, acts of God, civil insurrection, acts of government or governmental agencies, trade embargo, strikes or industrial disputes of a political motivated or regional nature or which impede movement of Goods) providing such delay occurs without the fault or negligence of Contractor.

14. Risk of Loss or Damage: Contractor shall have full risk of loss or damage to the Work at all times prior to its delivery to the IPSC job site for off-loading from Contractor's carrier by IPSC. IPSC will assume all risk of loss or damage to the Work during off-loading and at all times thereafter, provided, that during any period that Contractor shall have sole care, custody, and control of the Work, Contractor shall assume risk of loss or damage to the Work, subject to its limitation of liability.

15. Existing Conditions: It is understood and agreed by the parties that nothing herein shall be interpreted as placing any responsibility or liability on:

    a. Contractor and affiliated companies for site or equipment conditions related to pollution, contamination, hazardous waste, asbestos, or toxic material or for the generation, emission, or disposal of such substances; or

    b. IPSC for pollution, contamination, hazardous waste, asbestos, or toxic material introduced to the site or equipment by Contractor, including, but not limited to, the generation, emission, or disposal of such Contractor introduced substances.

    c. IPSC will protect and indemnify Contractor and affiliated companies against any and all claims or liabilities based on the conditions identified in subarticle a above; and Contractor shall protect and indemnify IPSC against any and all claims or liabilities based on the conditions identified in subarticle b above.

16. Proprietary Information: All information supplied by Contractor which is marked as "Proprietary" or "Confidential" shall be treated as the proprietary and confidential property of Contractor and shall be returned to Contractor upon request. IPSC will acquire no rights to Contractor's proprietary and confidential property. IPSC will not disclose such proprietary and confidential property to third parties or to employees who

IP7011581

do not have a need-to-know, without the written authorization of Contractor and the execution of a nondisclosure agreement whose terms are consistent with those set forth herein. In no event may disclosures be made to competitors of Contractor. This clause shall survive the termination of the Contract and be in effect as long as IPSC has possession of any proprietary or confidential property of Contractor. If IPSC is legally compelled or otherwise required to make disclosure to Governmental Regulatory or similar types of agencies, IPSC will notify Contractor prior to making disclosure and take all available steps to limit the extent of such disclosure so as to minimize the release of such information. IPSC will use its best effort to obtain from the agencies to whom the information is disclosed, written agreement to maintain the confidentiality of such information; however, failure to obtain such written agreement shall not bar any release which is made in accordance with the requirements hereof provided that notification has been given and the amount of information so released is minimized.

This obligation of confidentiality shall not apply to any Proprietary Information which is: (a) in the public domain at the time of disclosure or thereafter becomes part of the public domain by publication or otherwise; or (b) is in IPSC's possession prior to the disclosure as shown by written record; or (c) after it has lawfully been obtained by IPSC on a non-confidential basis from other sources having legally obtained such information.

Nevertheless, a copy of all drawings, specifications, calculations, models, data, and other engineering documents (collectively "Drawings") shall be delivered to and be retained by IPSC. IPSC shall be entitled to use the Drawings and the information contained therein for the construction, operation, maintenance, repair, alteration, improvement, and expansion of IPP Facilities.

17. Liquidated Damages: If Contractor fails to deliver the equipment within the time frame agreed, or any extension or change thereto, IPSC will be entitled to deduct liquidated damages from the Contract price unless it can be reasonably concluded from the circumstances of the particular case that IPSC has suffered no loss. Such liquidated damages shall be capped and have an overall maximum of 5 percent of the total equipment value. The rate of assessment shall be 1 percent per week of delay after a seven (7) calendar day grace period. The assessment of liquidated damages in any amount shall be considered full satisfaction for any liability whatsoever for Contractor for the delay.

IP7011582

PART F - DIVISION F2

GENERAL DESCRIPTION AND SCOPE OF WORK

1. General: The Intermountain Generating Station (IGS) consists of two (2) coal fired generating units with each having a maximum gross capacity of 950 Megawatts. IGS is operated and maintained by the Intermountain Power Service Corporation (IPSC).

   This Division covers the general description, scope of work, and supplementary requirements for equipment, materials, and services included under these Specifications.

   The equipment and materials covered by these Specifications will be incorporated in the Intermountain Power Project (IPP) ID Fan VFD System replacement project.

   The IPP Plant Site is located at 850 West Brush Wellman Road, Delta, Utah.

   It is desirable to provide the best suited and largest standard drive suitable for possible use at a later date due to unforeseen changes that may be required in the future.

   Reuse of the existing fan and motor is desirable. If the motor is reused, Contractor shall verify and warrantee the existing motor is acceptable for use with the new system.

   The existing output contactors and all power and control electronics shall be replaced. Contractor shall replace or reuse any and all other items as is deemed appropriate; however, Contractor shall include in its Proposal a complete description of the proposed system and what is being replaced and what is being reused.

   Contractor shall include in its Proposal a drawing showing the proposed arrangement and dimensions, including, clearances between existing items and all new items. This drawing shall also indicate the approximate weight of all components.

2. Existing System Description: Each generating unit has four (4) ID fan rated 7,415 HP at 954 RPM existing maximum speed limit. The motors are 6-phase synchronous, 8-pole, 3,876 volt machines. Each motor has two (2) 3-phase windings. Winding 1 is phase shifted thirty (30) electrical degrees from Winding 2. The motor windings are not re-connectable to change the motor voltage. Each motor is controlled by a pair of current source, load commutated inverter (LCI) variable frequency drives. Each drive has an input transformer to connect the 3,876 volt drive to the 6,900 volt circuit breaker. The transformer pairs are connected delta-delta and delta-wye such that the 6,900 volt bus sees harmonics associated with 12-pulse rectification at full load of the drives. The motors and drives are about twenty (20) years old and were manufactured by Westinghouse. The drive controls are a combination of analog and digital technologies.

3. New System Requirements: The replacement equipment must include features that will fulfill the following requirements:

IP7011583

Harmonic content on the 6,900 volt bus must meet IEEE 519.
Power factor at the 6,900 volt feed to each ID fan shall be 0.95 or better at full load. Contractor shall include in its Proposal the power factor at 25, 50, 75, 85, and 100 percent loads.
Existing fan capacities shall not be decreased.
External controls and interlocks of the new equipment shall coordinate with the existing plant control system.
New components proposed must not degrade rating or service life of existing components that are being reused.
Contractor shall include in its Proposal the guaranteed reliability and maintainability of ID fan system. New equipment must fit in existing space.
It is desirable to have the new equipment use the existing conduits that are encased in concrete to minimize the installation costs. If necessary, others will do core drilling of the concrete; however, Contractor shall list all core drilling necessary in its Proposal.
Equipment for VFDs shall be replaced and checked out during a scheduled twenty-four (24) calendar day outage. Contractor shall include in its Proposal a description of the ***work*** required for complete replacement.

4. Long Range Goals: The replacement equipment shall have features that will provide or make provision for the following goals:

Increased fan capacity to allow a 950 MW generating capacity with three (3) fans operating with additional pollution control equipment added.
Provide for future ID fan increases using Contractor's standard equipment.
Replace existing transformers.

5. Work Included Under These Specifications: The Work under these Specifications shall include furnishing F.O.B. at the IPP Plant Site, the medium voltage VFDs, miscellaneous materials, and services complete as specified herein and in accordance with the Contract Agreement.

All equipment and materials required for complete medium voltage VFD systems shall be furnished, except as specified otherwise in these Specifications. The equipment, materials, and services to be furnished shall include, but not necessarily be limited to, the following major items:

IP7011584

a. The furnishing of integrated medium voltage VFD systems, to operate the ID fans. Each set shall be an engineered system composed of the existing input switchgear, a VFD, self-contained closed cycle cooling system, and output contactor with connections to an existing or replacement ID fan motor. Drive equipment shall be housed in the existing control building. Equipment and software furnished shall be suitable for powering IPSC's ID fan motors or new motors provided by Contractor. Contractor shall identify any modifications required to IPSC's ID fan system, composed of ID fan motor, fan, connecting shaft, bearings, and cable connecting the ID fan motor to the VFD system to allow this equipment to operate with the VFD and still maintain a normal lifetime of the ID fan system. Contractor shall also provide services to coordinate the proper selection of IPSC's ID fan system and programming of the VFD software. This includes, but is not limited to, coordination of information transfer associated with IPSC's ID fan system, such as WK^2 of the fan, critical speeds, starting/running torque, and meetings with the new or existing fan motor supplier.

b. Each VFD system shall consist of all system components required to meet the performance, protection, safety, testing, and certification criteria of these Specifications. These components may include incoming harmonic filter/power factor correction unit, input isolation transformer, VFD converter/DC-link/inverter, and output filter. The VFD system shall represent a fully integrated package. All material and labor necessary to interconnect any VFD system elements shall be included, even if shipped separately, except as specified otherwise herein. The minimum VFD size shall be such that the motor will operate continuously at the horsepower rating multiplied by the motor service factor.

c. It is intended that Contractor's standard product, with available options, be provided under these Specifications. Any modifications to a standard product provided to meet these Specifications shall be performed by Contractor only. Contractor shall explicitly indicate all exceptions or deviations to these Specifications in its Proposal, per Division B1, Article 4, Instructions to Bidders. Only exceptions or deviations identified in the Proposal Section will be considered for negotiation and possible inclusion in the executed Contract.

d. The main VFD system components shall be completely factory prewired, assembled, and then tested as a complete package by Contractor, to assure a properly coordinated, fully integrated drive system. It is desirable that the factory acceptance tests include all components being furnished, including the transformer.

e. Contractor shall conduct a certified startup of all Contractor-furnished equipment to confirm conformance to these Specifications.

IP7011585

f. Any third party certification, safety, or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.

g. IPSC will test the equipment after erection to demonstrate its ability to operate under the specified conditions and fulfill the guarantees as set forth herein. If the tests indicate that the equipment fails to meet guaranteed performance, Contractor shall make additional tests and modifications until the equipment performs as specified.

h. Contractor shall provide drawings and other engineering data, manufacturer's field services, tools, instruction manuals, recommended spare parts list, and miscellaneous materials and services, and shall participate in design conferences, all as specified herein.

i. Equipment, materials, and accessories furnished shall be delivered to the IPP Job Site where items will be unloaded, received, stored, and erected under separate purchase orders. Deficiencies shall be sufficient cause to reject equipment. Unloading from carrier and storing will not constitute acceptance.

6. Miscellaneous Materials and Services: Miscellaneous materials and services not otherwise specifically called for shall be furnished by Contractor in accordance with the following:

a. All piping integral to or between any equipment furnished under these Specifications, except as otherwise specified.

b. All necessary instrument, power and control wiring, and raceways integral to any equipment furnished under these Specifications. This shall include terminal blocks and internal wiring to these terminal blocks for equipment requiring external connection.

c. Coupling guards for all exposed shafts and couplings.

d. Leveling blocks, soleplates, thrust blocks, and matching blocks.

e. Erection drawings, prints, information, instructions, and other data for use by IPSC's erection subcontractor.

f. Detailed storage and lubrication requirements (including frequencies) for use by IPSC's erection subcontractor.

g. The use of all special tools required for erection of the equipment, exclusive of the maintenance tools specified to be furnished under Division F3, Article 15, General Equipment Specifications. Erection tools shall remain the property of

IP7011586

Contractor and all shipping costs to and from the IPP Job Site shall be at Contractor's expense.

7. Work or Materials Furnished by Others: IPSC will furnish the following items:

a. ID fan system, composed of ID fan motor (if existing motor is used), ID fan, connecting shaft, bearings, and cable connecting the ID fan motor for each ID fan (if Contractor verifies existing cabling is acceptable). The connecting cable will be shielded 8 kV Type MV-90 single conductor medium voltage power cable. The WK^2 of the fan is 347,700 lb-ft^2. The fan will be a variable torque load and high breakdown/starting torque will be required.

b. One (1) or two (2) 6.9 kV incoming power feeds to each Contractor-furnished VFD system.

c. One (1) 125 volt DC power feed to each Contractor-furnished VFD.

d. One (1) 3-phase, 480 volt, 60 Hz, approximately 30 kVA exciter and auxiliary power supply per channel.

e. One (1) 1-phase,120 volt, 60 Hz, UPS supported control power source, approximately 2 kVA per channel.

f. Control wiring from IPSC's plant control system to the VFD control system.

g. Supply and install power cables as required to interconnect the VFDs, isolation transformers, input circuit breakers, and ID fan motors.

h. Receiving, unloading, storing, and field erection of all equipment.

i. Foundations, foundation bolts, bolt sleeves, and equipment bases.

j. Grouting materials and the placing thereof.

k. Permanent electric wiring to connect equipment terminal boxes to IPP's electrical system.

l. Lubricants and fuels for operation.

m. Solvents and cleaning materials.

n. Finish painting of all equipment except as specified herein.

o. Operating personnel for startup and tests.

8. Contractor's Services: Contractor's services as stated in Division F2, Article 5, Work Included Under These Specifications, shall be in accordance with the following:

a. Submittal of Engineering Data: Drawings and other engineering data for the specified equipment and materials are vital to the design and subsequent construction of the entire project.

Contractor will be required to submit drawings and engineering data in accordance with the schedule and requirements specified herein to assure compliance with the overall construction and operating schedule. Contractor shall allow a reasonable amount of time for mailing, processing, and IPSC Contract Administrator's review of drawings and data in Contractor's schedule and procurement/production/shipping schedule.

b. Manufacturer's Technical Services: Contractor shall furnish the service of one (1) or more manufacturer's technical service representatives. The service representatives shall be technically competent, factory trained, experienced in the installation and operation of the equipment, and authorized by the manufacturer to perform the Work stipulated.

The Manufacturer's technical service representatives shall furnish written certification to IPSC that, the equipment has been inspected and adjusted by or under representatives direction and that the equipment is ready for service, all of which shall be done before initial operation of the equipment.

The duties of manufacturer's technical services representatives may include, but may not be limited to, the following:

(1) Provide technical advice to assist the erection subcontractor in installing the equipment.

(2) Inspect and test the equipment after installation and direct any change or adjustments required to assure proper operation.

(3) Provide technical direction during startup and initial operation of the equipment.

(4) Direct the correction of any design or manufacturing errors.

(5) Instruct IPSC's personnel in the operation and maintenance of the equipment.

(6) Provide services required as a condition to providing the warranties and guarantees specified.

IP7011588

For each VFD system, the lump sum prices stated in the Proposal, shall include the recommended number of days of service and round trips to the IPP Job Site for field service. Contractor shall include as a minimum fifteen (15) days per drive. The manufacturer's technical representatives, shall provide the services specified under items (1), (2), (3), and (6) above. When, in the judgment of the Contract Administrator, field service representative's time is required under item (4) above solely and expressly, for the purpose of correcting design or manufacturing errors, no payment will be made, nor will the time spent at the IPP Job Site while correcting such errors apply toward the days of service or round trips specified in items (1), (2), (3), and (6) above.

When additional field service representatives time is required by IPSC under item (5) above, the per diem rates for service time, plus the rate for each round trip, will be paid in accordance with applicable adjustment prices for manufacturer's technical services as stated in the Proposal.

The per diem rates shall include all costs associated with the field service representative's Work at the IPP Job Site, including local travel, local travel time wages, and living expenses. The round trip rate shall include all expenses for travel to and from the manufacturer's facilities and the IPP Job Site, including any salary costs for travel time. IPSC will not reimburse Contractor for air fare costs exceeding tourist class air fare unless unusual circumstances exist. Contractor shall notify IPSC of such circumstances.

A day of service (per diem) is defined as eight (8) man-hours at the IPP Job Site. The total number of days of service shall be defined as the total regular time man-hours at the IPP Job Site divided by eight (8).

SIGMA Synchdrive Training Course to be held at Alstom's office in Pittsburgh, PA for a maximum of six (6) people for four (4) days of training in accordance with Alstom's quotation letter AP-IP-L-004, dated November 13, 2003. Date of training to be determined. Cost shall be an additional $9,250.

9. Instruction Manuals: Instruction manuals shall be furnished in accordance with the requirements stated in Division F4, Article 9, Engineering Data, of these Specifications and as scheduled herein.

10. Recommended Spare Parts: Contractor shall provide a complete listing of recommended spare parts with unit prices F.O.B., IPP Plant Site, not later than the date listed in Division F2, Article 15, Schedule of Activities. The listing shall include the manufacturer of each part, a description of each part (including industry standard part number if available), the assembly or equipment in which each part will be used, and recommended quantities to be stocked; shall classify the relative criticality of parts based on the manufacturer's experience; and shall list the lead time required for manufacturer and delivery of each part.

IPSC will retain the option of purchasing any one or any combination of spare parts listed at the prices quoted until six (6) months after final startup testing and acceptance.

11. Factory Witness Tests: Supplementing the provisions of Division F7 concerning factory witness tests, Contractor shall notify IPSC's Contract Administrator not less than ten (10) working days prior to the date of each factory witness test. IPSC's Contract Administrator will have the right to witness the factory acceptance test and be present for all other tests conducted.

12. Schedule: Contractor shall complete the specified activities in accordance with the milestone time periods and dates listed in addition to the timely delivery of the equipment and materials.

The Schedule of Activities stipulates the milestone dates and time periods for the Work included in the Contract. It is necessary that Contractor perform the activities shown on or before the dates indicated to avoid delay of the entire project.

a. Activity Periods and Dates: The time periods and dates listed in the Schedule of Activities indicate the latest dates by which the listed activities shall be completed. Data, drawings, and lists for planning, engineering, and documentation may be submitted earlier than the indicated dates at Contractor's option.

Equipment and materials shall be delivered within the time frame specified. IPSC will not be obligated to accept delivery or make payment for equipment delivered prior to the earliest acceptable delivery date.

b. Engineering Schedule: Contractor shall submit a schedule for engineering associated with the equipment being provided. Such schedules shall be updated and submitted by the first of each month until completion of the engineering effort.

c. Procurement/Production/Shipping Schedule: Contractor shall submit a detailed procurement/production/shipping schedule for the equipment and materials not later than the date indicated; thereafter, the schedule shall be updated as directed by IPSC's Contract Administrator; however, at least every thirty (30) days.

13. Reference Drawings: Contractor shall field verify the information shown on the referenced drawings for any information that is used in the design and fabrication of the variable frequency ID fan drive equipment. All travel and living expenses expended by Contractor for field verification of Reference Drawings, shall be included in the lump sum Contract price. Refer to Division F2, Drawing List, for drawings included with these Specifications.

IP7011590

14. Right to Operate Unsatisfactory Equipment: If the operation of the equipment after installation proves to be unsatisfactory to the Contract Administrator, IPSC shall have the right, but no duty, to operate such equipment until it can be taken out of service without injury to IPSC for the correction of defects, errors, or omissions.

15. Schedule of Activities: Contractor shall be required to complete the following:

Activity	Days After Award of Contract
Planning, Engineering, and Documentation	
Participate in Design Conference at the IPP Job Site	Fifteen (15) Days
Supply Schedule of Engineering	Fifteen (15) Days
Supply Quality System Manual as Specified in Division F3	Submitted with Bid
Supply Inspection and Test Plan as Specified in Division F3	Thirty (30) Days Prior to First Fabrication
Supply Notification of Tests/Test/ Inspections as Specified in Division F3	Ten (10) Days Prior to Inspection
Supply Hazardous Materials Documentation	Thirty (30) Days After Award of Contract and With Material Lists
Supply Outline Drawings	Fifteen (15) Days
Supply Schematic and Wiring Diagrams	Twenty (20) Days
Supply Input/Output List to Plant Control System	Fifteen (15) Days
Supply Block Diagram Showing Basic Control and Protection Systems Specifying the Protection, Control, Trip, and Alarm Functions at Different Locations; and Reference Signals, Commands, and Auxiliary Supplies (i.e., Air, Oil, and Cooling Water)	Thirty (30) Days
Supply Single-Line Diagram Showing Main and Auxiliary Circuitry, Including Main Power Input, Switchgear, Transformer, VFD, System Earthing and Auxiliary Supplies, Showing All CTs, PTs, Relays, Meters, etc., for the Control, Protection, and Operation of Drive System with Electrical Data (i.e., Voltage, Current, Time Ratings, Impedances, and Tolerances)	Thirty (30) Days

IP7011591

Activity	Days After Award of Contract
Planning, Engineering, and Documentation	
Supply Nameplate Drawings	Thirty (30) Days Before Shipping
Supply Torsional Analysis	As Directed by IPSC
Supply Efficiency and Power Factor Values	Fifteen (15) Days
Supply Startup and Commissioning Instructions and Data	Six (6) Weeks Prior to Shipment
Supply VFD Equipment Interface Information, Including Dead and Seismic Loads	Twenty (20) Days
Supply Anchor Bolt Information, Including Material, Size, and Projection	Twenty (20) Days
Supply Certified Report, Including Test Data for all System Level Tests	Fifteen (15) Days After Completion of System Level Tests
Supply Schedule of System Level Tests, Including Proposed Test Procedures	Thirty (30) Days Prior to Tests
Supply Schedule of Certified Field Startup and Acceptance Tests	Thirty (30) Days Before Shipment
Supply Completed Motor Information Sheets to IPSC's Contract Administrator	N/A
Supply Cash Flow Projection	N/A
Supply Initial Detailed Procurement, Production, Shipping Schedule	Fifteen (15) Days
Supply Recommended Detailed Erection Sequence and Procedure	Thirty (30) Days
Submit "Proof Copy" of Instruction Manual(s) to IPSC's Contract Administrator	Thirty (30) Days After Shipment
Distribute Twelve (12) Copies Each for Unit 1 and 2 of Accepted Instruction Manuals as Designated by IPSC's Contract Administrator	Thirty (30) Days After Startup
Supply Recommended Spare Parts List to IPSC's Contract Administrator	Thirty (30) Days After Shipment

IP7011592

Activity	Days After Award of Contract
Planning, Engineering, and Documentation	
Notify IPSC's Contract Administrator for Pre-Shipment Inspection	Thirty (30) Days Prior to Shipment
Notify IPSC's Contract Administrator of Factory Witness Test(s)	Ten (10) Days Prior to Date of Test(s)

Equipment to be Delivered to IPP Job Site		
Equipment	**Earliest Acceptable Delivery Date**	**Latest Acceptable Delivery Date**
Unit 2 - One (1) Fan	January 02, 2004	February 25, 2004
Unit 1 - Two (2) Fans	January 02, 2005	January 31, 2005
Unit 2 - Three (3) Fans	January 02, 2006	January 31, 2006
Unit 1 - Two (2) Fans	January 02, 2007	January 31, 2007

Twenty-Four (24) Day Plant Outages (For Installation of Equipment, Final Startup Testing, and Acceptance)	
Unit	**Date**
Unit 2 - One (1) Fan	March 2004
Unit 1 - Two (2) Fans	March 2005
Unit 2 - Three (3) Fans	March 2006
Unit 1 - Two (2) Fans	March 2007

Note: Exact Dates to be Determined After Award of Contract

IP7011593

DRAWING LIST

The following reference drawings and pictures are included on the CD that is included with these Specifications:

Existing Design Drawings		
Drawing Number	**Rev**	**Title**
9255-1APE-E1002	9	One-Line Diagrams Overall Functional Relaying
9255-1APE-E1006	8	One-Line Diagrams 6900V Unit Switchgear 1A2
9255-1APE-E1008	9	One-Line Diagrams 6900V Unit Substation 1B2
9255-1BSB-M1040	13	Plant Arrangement - AQCS Control Bldg and ID Fan Area Ground Floor - El 4676'0"
9255-1BSB-M1041	9	Plant Arrangement - AQCS Control Bldg and ID Fan Area Mezzanine Floor - El 4692'0"
9255-2APE-E1002	4	One-Line Diagrams Overall Functional Relaying
9255-2APE-E1006	5	One-Line Diagrams 6900V Unit Switchgear 2A2
9255-2APE-E1008	5	One-Line Diagrams 6900V Unit Substation 2B2
9255-2BSB-M1040	8	Plant Arrangement - AQCS Control Bldg and ID Fan Area Ground Floor - El 4676'0"
9255-2BSB-M1041	6	Plant Arrangement - AQCS Control Bldg and ID Fan Area Mezzanine Floor - El 4692'0"
Existing ID Fan Drawings		
Drawing Number	**Rev**	**Title**
2090F87	7	Contract Drawing 4132 Special ID Fan CL. 954 ARR. 3 DW W/324" Boxes 60" Tau Disch. CW & CCW Rota
2429D95	2	Fan Foundation System Design Criteria Category IV for Adjustable Speed Drive Systems

IP7011594

Existing Drive and Motor Drawings Pictures	
File Name	**Description**
Pb130002.jpg	Looking West at Unit 2 Wall of AQCS Control Building
Pb130003.jpg	Looking West at Unit 2 Wall of AQCS Control Building and ID Fan 1A
Pb130010.jpg	Looking West at Unit 1 Wall of AQCS Control Building
Pb130012.jpg	Looking West at Uni1 Wall of AQCS Control Building and ID Fan IA

Note: The existing drive and motor drawings are included as files 00250001.tif through 00250156.tif.

IP7011595

PART F - DIVISION F3

GENERAL EQUIPMENT SPECIFICATIONS

1. General: These General Equipment Specifications apply in general to all equipment and materials and are supplementary to the Detailed Specifications. If requirements specified herein are in conflict with requirements specified in the Detailed Specifications, the Detailed Specifications shall govern to the extent of such conflict.

   The Proposal shall be based upon the use of equipment and materials complying fully with the requirements specified in the Contract Documents. It is recognized that Contractor may have standardized on the use of certain components, materials, processes, or procedures different than those specified herein. Alternates in addition to the base Proposal on the basis of supplying Contractor's standard components, materials, processes, or procedures will be considered. The alternate Proposal shall clearly stipulate the alternate proposed, the specific exceptions to the specifications, and the price change applicable for suppling such alternate.

2. Referenced Standards: Reference to the standards of any technical society, organization, or association, or to the laws, ordinances, or codes of governmental authorities shall mean the latest standard, code, or specification adopted, published, and effective at the date of taking bids unless specifically stated otherwise in these Specifications.

   The specifications, codes, and standards referenced in these Specifications (including addenda, amendments, and errata) shall govern in all cases where references thereto are made except where they conflict with these Specifications. In case of conflict between the referenced specifications, codes, or standards and these Specifications, the latter shall govern to the extent of such difference.

3. Materials and Equipment: Unless specifically provided otherwise in each case, all materials and equipment furnished for permanent installation in the Work shall conform to applicable standard specifications and shall be new, unused, and undamaged.

4. Identification: All correspondence, shipping notices, specifications, engineering data, and other documents pertaining to the equipment and materials furnished under these Specifications shall be identified by IPSC's name, the project name and number, the unit number, and the Specifications number.

5. Pre-Shipment Inspection: IPSC Contract Administrator reserves the right to inspect the equipment prior to shipment. Contractor shall notify IPSC's Contract Administrator of all shipments not less than ten (10) working days prior to the date of shipment to allow IPSC's Contract Administrator to inspect the equipment if so desired.

6. Material List: Contractor shall prepare and submit with the first shipping notice two (2) copies of an itemized material list covering all material and equipment furnished under

IP7011596

these Specifications. The material list shall be in sufficient detail to permit an accurate determination of the completion of shipment.

7. Hazardous Materials: All shipments of hazardous materials shall be identified on the material list. A copy of the hazardous materials documentation required per Division F1, Detailed Specifications - Special Conditions, Article 9, Material Safety Data Sheets, shall be included with the material list and shall also be included with the shipping papers attached to the shipment.

8. Correction of Errors: Equipment and materials shall be complete in all respects within the limits herein outlined. All errors or omissions required to be corrected in the field shall be done by the manufacturer or his duly authorized representative at Contractor's expense.

9. Numbering System: IPSC has established an identification numbering system to provide consistent numbering of all plant equipment. All electrical devices, control and instrumentation equipment, valves, and other items of similar nature shall be permanently identified with the identification number supplied by IPSC. Except as specified otherwise in these Specifications, the identification shall be engraved on stainless steel tags, laminated phenolic tags, nameplates, or an equally permanent method at the option of, and as acceptable to, IPSC and shall be permanently affixed to the device. IPSC's identification numbers shall also be included on the manufacturer's drawings.

10. Nameplates: Nameplates shall be furnished for all equipment when specified in the Detailed Specifications.

    Nameplates shall be laminated white phenolic engraving stock with black core, or 2-ply vinyl white with reverse engraved black fill as manufactured by B.F. Plastics of Lawrence, Ohio, or acceptable equal. The lettering shall not be less than 3/16 inch high. As space permits, nameplates shall have an overall minimum size of 3/4 inch by 3 inches for small equipment nameplates, and 2 inches by 8 inches minimum for major equipment nameplates. The nameplate size shall be subject to acceptance by IPSC during drawing review. Nameplates shall be attached with stainless steel screws.

11. Factory Assembly: Equipment shall be shipped completely factory assembled, except when the physical size, arrangement or configuration of the equipment, or shipping and handling limitations make the shipment of completely assembled equipment impracticable, in which case the equipment shall be assembled and shipped as stated in Contractor's Proposal.

    All separately packaged accessory items and parts shall be shipped with the equipment. Containers for separately packaged items shall be marked so the containers are

IP7011597

identified with the main equipment. An itemized packing slip, indicating what is in that container only, shall be attached to the outside of each container used for packaging. A similar list shall be inside of each container. A master packing slip, covering all accessory items for a given piece of equipment which are shipped in separate containers, shall be attached to one (1) container.

12. Service Conditions: Unless specified otherwise, equipment and material furnished under these Specifications shall be suitable for service at an altitude of 4,700 feet above sea level, temperatures between 0°C and 50°C.

    Equipment located outdoors shall also be suitable for exposure to solar radiation, fog, rain, snow, ice, coal dust, fly ash, wind, and windblown dust and sand.

13. Control and Electrical Equipment: Control and electrical equipment, including panels, cabinets, switchgear, transformers, and motors, shall be finish painted. Exterior surfaces shall be the manufacturer's standard color. The interior portions of cabinets shall be gloss white. Touch-up paint shall be provided for repair painting.

14. Protection: All equipment shall be boxed, crated, or otherwise suitably protected during shipment, handling, and storage.

    Electrical equipment, controls, and insulations shall be protected against moisture and water damage.

15. Tools: Contractor shall furnish and ship with each piece of equipment one (1) set of all special tools required for installation and maintenance of the equipment. Maintenance tools for each piece of equipment shall be boxed separately and the boxes shall be marked with the large painted legend as follows:

    INTERMOUNTAIN POWER SERVICE CORPORATION
    INTERMOUNTAIN POWER PROJECT
    MAINTENANCE TOOLS FOR: _____
    (Name of Equipment)

    ERECTION SUPPLIER DO NOT OPEN EXCEPT WITH IPSC'S PERMISSION

    A weatherproofed itemized list of the contents shall also be attached to the outside of each box.

    The maintenance tools shall include all special handling rigs, bars, slings, and cable. All maintenance tools shall be in new and unused condition and shall become the property of IPSC. The bidder's Proposal shall include the list of maintenance tools which shall be furnished with the equipment.

IP7011598

In addition to the tools for maintenance and dismantling, Contractor shall furnish the use of all special tools required for erection of the equipment. Erection tools shall remain the property of Contractor and all shipping costs to and from the IPP Job Site shall be at Contractor's expense. Erection tools for each piece of equipment shall be boxed separately. Erection tools shall not be boxed with maintenance tools.

16. Alignment and Balance: All rotating parts shall be true and dynamically balanced. Excessive noise or vibration, in the opinion of IPSC's Contract Administrator, will be sufficient cause for rejection of the equipment. All rotating equipment shall be balanced at the factory.

17. Noise Level: The equivalent "A" weighted sound pressure level for equipment furnished under these Specifications (excluding drive motors) shall not exceed 85 dBA free field measured 3 feet horizontally from the base of the equipment and 5 feet about floor level. If the drive motors for the equipment are also furnished under these Specifications, the combined sound pressure level of the motor and driven equipment shall not exceed 90 dBA free field. The sound pressure levels stated are decibels to a reference of 20 micropascals.

18. Design Coordination: Contractor shall be responsible for the selection and design of all equipment and materials which Contractor is providing. Contractor shall select equipment including power converters, heat exchangers, and output switches which will provide the best coordinated performance of the entire system. Components of rotating equipment shall be selected so that the natural frequency of the complete unit is not at or critically near the operating range of the unit.

19. Control Power: Electrical power for control and instrumentation will be a nominal 120 volt, single-phase, 60 hertz, alternating current, or a nominal 125 volt direct current. Contractor shall provide any devices required for proper operation and protection of the equipment during electrical power supply and ambient temperature fluctuations described in the following paragraphs.

All dc electrical control devices shall be designed for continuous operation on an ungrounded station battery at any voltage from 100 to 140 volts dc. Electrical devices served from this supply shall not impose any ground connections on it. All ac electrical control devices shall, unless other specified, be designed for continuous operation at any voltage from 102 to 132 volts alternating current. The dropout voltage shall be less than 75 volts for relays and 90 volts for contactors and starters. Alternating current electrical control devices operating at nominal voltages other 120 volts shall be designed for continuous operation over proportional voltage variations.

All devices shall be guaranteed to operate satisfactorily under voltage conditions specified in the above paragraphs and at a range of ambient temperatures from 50°C to -35°C outdoors and from 50°C to 0°C indoors (non-freezing.)

IP7011599

20. Auxiliary Power: Auxiliary equipment, such as motors, transformers, and rectifiers, requiring electrical power shall be designed to operate from one of the nominal electrical power sources as follows:

Auxiliary Power		
Volt	**Phase**	**Hertz**
6,900	3	60
480	3	60
208	3	60
120	1	60
125	dc	– (Emergency)

Alternating current motor voltage ratings with relation to horsepower shall be in accordance with the following:

Alternating Current Motor Voltage Rating		
Horsepower	**Volt**	**Phase**
Below ½	115	1
½ through 249	460	3

21. Electrical Enclosure Heating: Where electrical enclosure heating is specified, at least two (2) space heaters, one (1) adjustable thermostat, and one (1) fuse and fuse block shall be provided completely wired in the enclosure. The space heaters, thermostat, and fuse block shall not interfere with normal cable entrance into the enclosure or with maintenance or replacement of devices within the enclosure. Normal use of space heaters shall not change or discolor any painted surface.

Space heater capacity shall be as required to maintain the enclosure internal temperature above the dew point under the specified service conditions. Space heater voltage, for circuits greater than 1,000 watts rating shall be 208 volts. Voltage applied to space heaters, less than 1,000 watts shall be 120 volts. Space heaters shall be controlled by an adjustable thermostat, factory set to close on falling temperature at 80°F (on) and open on rising temperature at 95°F (off). The thermostat shall incorporate an indicating thermometer and set point temperature indication.

Any thermally controlled devices within the enclosure shall be temperature compensated for correct operation at 85°F and above.

Space heater leads shall be stranded copper cable with 600 volt insulation and shall include terminal connectors. Space heater sheaths shall be of a corrosion-resistant, nonoxidizing material and shall have a thickness not less than 0.025 inch.

22. Wiring: In general, all devices furnished under these Specifications and requiring electrical connections shall be designed for wiring into electrical enclosures with terminal blocks. Terminal blocks shall be furnished for conductors requiring connection to circuits external to the specified equipment, for internal circuits crossing shipping splits, and where equipment parts replacement and maintenance will be facilitated. Internal current feedback circuits shall be wired point-to-point without any terminal blocks.

Splices will not be permitted.

One (1) spare normally open and one (1) spare normally closed contact on each control switch and lockout relay shall be wired out to terminal blocks.

All wiring leaving an enclosure shall leave from terminal blocks and not from other devices in the enclosure.

Auxiliary equipment such as terminal blocks, auxiliary relays, or contactors shall be readily accessible. Auxiliary equipment shall be located in compartments, enclosures, or junction boxes in such arrangement that a serviceman will have direct access to the equipment without removal of barriers, cover plates, or wiring.

Terminal blocks for external connections shall be grouped in the instrument and control compartment for easy accessibility, unrestricted by interference from structural members and instruments. Sufficient space shall be provided on each side of each terminal block to allow an orderly arrangement of all leads to be terminated on the block.

Terminal blocks shall not be mounted in compartments containing cables or buses operating at voltages above 600 volts.

Internal feedback CTs are not being run to terminal blocks. The shorting-type terminal blocks shall be furnished with white marking strips. All electrical cables shall be conservatively selected for the electrical and environmental conditions of the installations and shall be of the best construction for the service where unusual service conditions are encountered. Proper temperature application cable shall be used throughout. Except where required to be otherwise to perform satisfactorily in the service, or unless otherwise specified in the Detailed Specifications, all electrical power and control conductors shall be Class B, stranded copper conductors, 14 AWG or larger. Internal wiring to circuit boards shall be sized in accordance with Contractor's standards.

IP7011601

Electrical cables which utilize mineral insulation (NEC Type MI) or polyvinyl chloride (PVC) insulation (NEC Types AWM, MTW, TA, TBS, THHN, THHW, THWN, TW, or THW) shall not be utilized. PVC shall not be utilized as a jacketing material on any of the cable constructions.

Control panel and cabinet wiring shall utilize stranded copper conductors with flame retardant cross-linked polyethylene or flame retardant ethylene-propylene rubber insulation rated 600 volts and shall meet the requirements of UL 44 for Types SIS and XHHW. The cables shall also meet the UL 44 VW-1 flame test and shall be Rockbestos Type SIS, VW-1; American Insulated Wire Type SIS, VW-1; Continental Wire & Cable Type SIS, VW-1; or acceptable equal.

Preinsulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Preinsulated terminal connectors shall include a metallic support sleeve bonded to the vinyl insulating sleeve and designed to grip the conductor insulation.

Ring-type connectors shall be manufactured by AMP, 3M, or acceptable equal. Spade-type connectors shall be AMP slotted spring spade or 3M Scotchlok Series 61 snap spade terminal connectors.

Each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary device shall be permanently labeled to coincide with the identification indicated on the drawings. All terminals provided for termination of external circuits shall be identified by inscribing circuit designations acceptable to IPSC's Contract Administrator on the terminal block marking strips with permanent black ink. All other wiring terminations shall be identified by printing on conductor identification sleeves. A conductor identification sleeve shall be provided on each end of each internal conductor. Conductor identification sleeves shall be PVC, not less than ½ inch long, and shall be as manufactured W.H. Brady Company, Milwaukee, Wisconsin, or acceptable equal. Conductor identification shall be printed on the sleeve with permanent black ink acceptable to IPSC's Contract Administrator. After inscription of the conductor identification, the sleeve shall be coated as required to prevent smudging. Conductor identification shall be permanent, unaffected by age, heat, solvents, or steam, and not easily dislodged. Adhesive labels are not acceptable.

The arrangement of connections on terminal blocks shall be acceptable to IPSC. All connections requiring disconnect plug and receptacle-type devices shall be provided with factory terminated conductors on each plug and receptacle. Plugs and receptacles shall be factory wired into junction boxes containing terminal blocks for external connections. All conductors on the disconnect portion of plug-receptacle assemblies shall be in a common jacket.

All temporary wiring installed in the factory for equipment testing shall be removed prior to shipment of the equipment.

23. Equipment Safety Grounding: All electrical equipment that is part of an integral shipping unit or assembly shall be furnished with bare copper grounding conductor extending to a central ground connection lug. The lug shall be suitable for field connection to the station ground grid by others.

Isolated logic system or single-point ground connections required for proper operation of electronic equipment shall be insulated from the equipment safety ground. Such connections shall be extended, using insulated cable, to a single termination point suitable for field connection to the appropriate ground system by others.

Electrical equipment shall include all enclosures containing electrical connections or bare conductors with the exception of control devices, such as solenoids, pressure switches, and limit switches, unless such devices require grounding for proper operation.

24. Terminal Blocks: Terminal blocks shall be furnished with white marking strips and, where permitted by the safety codes and standards, shall be without covers. Twenty percent spare terminals shall be furnished.

All terminal blocks, except internal terminal blocks in factory prewired electronic systems cabinets and terminal blocks for thermocouple extension wire, shall be Buchanan Medium Duty, rated 600 volts, with thermocouple contacts or Marathon 200 Series with Omega Engineering, Inc., Type TL terminal lugs for terminal blocks, or acceptable equal. Contractor shall provide stud-type terminals for all IPSC connections. Terminal blocks shall be appropriately sized for larger wire size or higher voltage insulated incoming conductors as necessary.

States stud-type terminal blocks are not Alstom's standard. States terminal blocks shall be provided in lieu of Alstom's standard for the incremental cost incurred. Cost shall be $1,710 per unit.

25. Indicating Lights: Status indicating lights shall be either Micro Switch Type PTW, with Type 387 lamps, plastic lenses, and appropriately sized resistors; General Electric Type ET-16, with incandescent screw connectors, plastic lenses, and appropriately sized resistors; or acceptable equal.

Engraved indicating lights shall be Honeywell Micro Switch Series 2 with Type 387 lamps or acceptable equal.

Indicating lights shall be energized when the condition exists and shall be de-energized when the condition does not exist. Indicating light lens colors shall be coordinated with indicated conditions as specified in the following table:

IP7011603

Lens Color	Condition
Red	Equipment Energized, Such as Motor Running, Valve Open, or Breaker Closed
Green	Equipment De-Energized, Such as Motor Stopped, Valve Closed, or Breaker Open
White	Equipment Abnormality, Such as Motor Trip or Breaker Trip
Amber or Yellow	Equipment Start Permissive

26. Alarm Contacts: Alarm contacts for remote annunciation shall be suitable for operation at 125 volts dc. All contacts shall be rated at least 0.5 ampere make or break, at 125 volts dc. Alarm contacts shall be normally closed contacts which open to alarm condition.

27. Molded Case Circuit Breakers: Molded case circuit breakers used in equipment furnished under these Specifications shall be as listed in the following tables:

AC Service							
				Interrupting Capacity (NEMA)			
				AC		DC	
Pole	Service Volt AC	Frame Rating Ampere	Trip Range Ampere	Symmetrical Ampere	Volt	Ampere	Volt
1	120	100	15-100	10,000	120	5,000	125
2	208	100	15-100	10,000	240	5,000	250
2	480	100	15-100	25,000	480	10,000	250
3	208	100	15-100	10,000	240	**	**
3	480	100	15-100	25,000	480	**	**
2	480	225		25,000	480	10,000	250
3	480	225		25,000	480	**	**

**The construction of all 3-pole circuit breakers furnished under these Specifications shall be equivalent to 1-pole and 2-pole circuit breakers specified. This shall include heavy-duty construction and spacing between poles as required for dc rated circuit breakers.

IP7011604

DC Service							
				Interrupting Capacity (NEMA)			
				AC		DC	
Pole	Service Volt DC	Frame Rating Ampere	Trip Range Ampere	Symmetrical Ampere	Volt	Ampere	Volt
2	125	100	15-100	10,000	120	5,000	125

28. Factory Prewired Electronic Systems Cabinets: Internal wiring in factory prewired electronic systems cabinets may be installed according to Contractor's standard as to wire size, insulation, and method of termination on internal equipment except that insulation for all wiring (including circuit board wiring, back plane wiring, and power supply wiring) shall meet the VW-1 (vertical wire) flame test requirements of UL 44. Interconnecting cables between devices shall meet the flame test requirements of IEEE Standard 383 (ANSI N41.10) using a gas burner flame source. The individual conductors of the interconnecting cables shall meet the flame resisting test requirements of ICEA S-19-81, Paragraph 6.19.6. Identification of conductors may be done by insulation color coding identified on drawings or by printed wiring lists. Terminal blocks for connection of external circuits into factory prewired electronic systems cabinets shall meet all the requirements of Article 24, Terminal Blocks, of this Division.

29. Solid-State Logic Systems: All electrical equipment containing solid-state logic systems shall be tested in accordance with the manufacturer's standard tests for a minimum of 120 hours under power prior to shipment from the factory. The components to be tested shall include the electronic devices, power supplies, input/output devices, operator interface devices, and interconnecting cables provided with the system. The system shall be tested as a complete assembly. Testing of individual components or modules will not be acceptable as system tests. Testing should be done at maximum operating temperature. All solid-state boards should under go a burn in phase prior to any actual tests.

    A description of the manufacturer's standard factory test procedure shall be provided in the Proposal.

30. Contractor-Furnished AC Motor Starters: The AC motor starters furnished with the equipment shall provide wiring in accordance with the following requirements:

    Motor starters for 480 volt AC service shall include 480 volt, 3-phase, 60 hertz contactors with manual reset thermal overload relays, 120 volt ac operating coils, and 480 to 120 volt dry-type control transformers complete with one secondary lead fused and the other secondary lead grounded.

PART F - DIVISION F4

ENGINEERING DATA

1. General: This Division stipulates the requirements for engineering data which Contractor shall submit to IPSC for design information and review. Compliance with the specified schedule for engineering data submittal is vital to the scheduled progress and completion of the Project.

   All engineering data shall be identified with the equipment or structure it represents by use of the nomenclature established by the Contract Documents. Equipment drawings shall have IPSC's equipment name and number clearly displayed. Material drawings shall have the engineer's structure name and structure number (when applicable) clearly displayed.

   a. Document Index: A document index listing all drawings and data to be submitted shall be included with the initial submittal. The document index shall be resubmitted as required to indicate revisions to the list. The list shall include the document number and title, if known, or the general document category, e.g., wiring diagrams for each item of equipment.

2. Review of Engineering Data: IPSC's review of engineering data will cover only general conformity of the data to the specifications and documents, external connections, interfaces with equipment and materials furnished under separate specifications, and dimensions which affect plant arrangements. IPSC's review does not indicate a thorough review of all dimensions, quantities, and details of the equipment, material, device, or item indicated or the accuracy of the information submitted; nor shall review by IPSC be construed as relieving Contractor from any responsibility for errors or deviations from the requirements of the Contract Documents.

   All engineering data submitted, after final processing by IPSC shall become a part of the Contract Documents and the Work indicated or described thereby shall be performed in conformity therewith, unless otherwise required by IPSC.

3. Performance Curves: If applicable, six (6) copies of the performance curves shall be submitted as scheduled in Division F2, General Description and Scope of Work.

4. Design Data: If applicable, six (6) copies of the design data shall be submitted as scheduled in Division F2, General Description and Scope of Work.

5. Test and Inspection Data: Certified copies of test and inspection reports shall be provided by Contractor for all tests and inspections conducted on the specified equipment. Six (6) copies of each report shall be submitted to IPSC within two (2) weeks after completion of each test or inspection.

IP7011606

6. Motor Information Sheets: Motor Information Sheets are included at the end of this Division. If applicable, a copy of the appropriate sheets shall be completed for each motor furnished under these Specifications. Copies of the completed sheets shall be submitted as specified in this Division and as scheduled in Division F2, General Description and Scope of Work. The number of copies submitted shall be the same as for other manufacturer's drawings.

7. Drawings: Drawings shall be in sufficient detail to indicate the kind, size, arrangement, weights of each component, breakdown for shipment, and operation of component materials and devices; the external connections, anchorages, and supports required; the dimensions needed for installation and correlation with other materials and equipment; and the information specifically requested in the drawing submittal schedule specified in Division F2, General Description and Scope of Work.

Drawings shall be fully completed and certified by Contractor as to the compliance of the information contained thereon with the requirements of these Specifications. Drawings shall have title block entries clearly indicating the drawing is certified. Drawings will be reviewed by IPSC and processed as specified in this Division.

Each drawing submitted shall be clearly marked with the name of the Project, the unit designation, the Specification title, the Specification number, the project equipment or structure nomenclature, Contractor's name, and IPSC's drawing number (after it is assigned upon initial submittal of the drawing). Catalog pages are not acceptable. If standard drawings are submitted, the applicable equipment and devices furnished shall be clearly marked. Separate drawings shall be submitted for each of the two (2) generating units.

Drawings shall be submitted in accordance with the schedule specified in Division F2.

a. Drawing Submittal: Six (6) prints of each drawing shall be submitted. Prints shall be black line on white background. Print size shall not exceed 34 inches by 44 inches unless due to the size of the equipment larger drawings are necessary. Drawings shall be folded to 8-1/2 inches by 11 inches. One (1) copy of each drawing shall be submitted in AutoCAD 2002 drawing file format.

Drawing and lettering practices shall be in accordance with Contractors Engineering Work Instruction (EW40502) "CAD Standards."

b. Drawing Processing: A copy of each drawing reviewed will be returned to Contractor as stipulated herein. Copies of drawings returned to Contractor will be in the form of a print with IPSC's marking.

When drawings and data are returned marked '*exceptions noted*', the changes shall be made as noted thereon, and six (6) corrected copies shall be submitted to IPSC.

IP7011607

When the drawings and data are returned marked '*returned for correction*', the corrections shall be made as noted thereon and as instructed by IPSC and six (6) corrected copies shall be submitted.

When a drawing is revised and resubmitted, Contractor shall include an issue number and revision description in the drawing revision block. All revisions pertaining to that particular drawing issue shall be clouded or otherwise clearly noted on the drawing.

When the drawings are returned marked '*no exceptions noted*' or '*received for distribution*', Contractor shall submit drawings for final distribution as specified hereinafter under Final Drawings. Drawings marked '*received for distribution*' have been filed; however, have not been reviewed.

No Work shall be performed in connection with the fabrication or manufacture of equipment and materials until the drawings and data therefor have been reviewed by IPSC except at Contractor's own risk and responsibility. Work may proceed on equipment and materials when the drawings and data therefor have been returned marked '*no exceptions noted*' or '*received for distribution*', and when drawings have been returned marked '*exceptions noted*', provided the Work is performed in accordance with IPSC's notations.

If changes are made to the equipment at the IPP Job Site, revised drawings indicating the changes made shall be prepared by Contractor and submitted to IPSC.

c. Final Drawings: Upon receipt, from IPSC, of drawings marked '*no exceptions noted*' or '*received for distribution*', Contractor shall transmit seven (7) additional prints of each drawing to IPSC for final distribution. However, if during the submittal process, Contractor makes further changes to drawings that have been reviewed by IPSC, the changes shall be clearly marked on the drawings and the submittal process shall be repeated.

d. Electronic File Copies: One (1) electronic copy, in AutoCAD drawing file format, of each final electrical wiring and elementary diagram for equipment shall be furnished. Electronic copies shall be submitted to IPSC on archival quality compact disks.

8. Wiring Diagrams: Connection and interconnection wiring diagrams, separate from connection and interconnection data contained in the standard supplied drive system elementary drawing are not furnished; however, IPSC's terminal block orientation is shown with sufficient room for adding IPSC's external cabling. The wiring diagrams shall be drawn with all devices indicted in their relative physical locations and shall represent the equipment and terminals arranged as they would appear to a person wiring the equipment.

IP7011608

Wiring diagrams shall be prepared on sheets approximately 30 inches by 42 inches. Where interconnecting wiring from different items of equipment or sectional wiring diagrams of the same item of equipment appear on different wiring diagram sheets, all interconnections shall be clearly identified. Where sectional wiring diagrams are required for a single item of equipment, such as a relay panel or control panel, that section of the panel which is represented by each individual wiring diagram sheet shall be keyed on that sheet in a manner acceptable to IPSC.

Information indicated on Contractor's drawings shall include wiring of the individual panel items as they actually will appear in the panel, contact arrangements of switches, and internal wiring of relays and instruments.

Elementary diagrams shall be cross-referenced to terminal markings on the connection and interconnection diagrams; however, need not indicate complete details of circuits external to the panels. Each item of panel-mounted equipment indicated on the diagrams shall be identified by item number and name.

Sufficient space shall be left on IPSC's side of outgoing terminal blocks for adding cable color codes and circuit numbers. Color codes and circuit numbers will be added by IPSC. Contractor shall be responsible for adding the color codes and circuit numbers to its drawings after they are assigned by IPSC.

Contractor shall provide drawings showing terminal blocks for IPSC's connections.

9. Instruction Manuals: Instruction manuals for the unloading, storage, installation, operation, and maintenance of the equipment shall be furnished. The number of manuals and the required time of delivery are specified in Division F2, Article 15, Schedule of Activities.

a. Content: Manuals shall include the following information specific to the furnished equipment:

Contents of Manual(s)
Table of Contents and Index Tabs
Specifications, Test Data, and Curves
Description of the Equipment
Instructions in the Methods of Receiving, Inspection, Storage, and Handling Prior to Installation

IP7011609

Contents of Manual(s)
Installation Instructions, Including Instructions for Any Modifications That Are Required for Existing Equipment
Operating Instructions
Maintenance Instructions
Assembly Drawings
Parts Lists
List of Acceptable Lubricants
Nameplate Information and Shop Order Numbers for Each Item of Equipment and Component Part Thereof
List of Recommended Spare Parts
List of Maintenance Tools Furnished with Equipment

The above listed requirements are minimum; however, requirements which are clearly not applicable to the equipment may be deleted. Additional information which is necessary for proper operation and care of the equipment shall also be included.

b. Binding: Each copy of the manuals shall be assembled and bound in a special binder in accordance with the following:

Binding	
Manufacturer:	Viatech Publishing Solutions 424 North Cedarbrook Avenue Springfield, Missouri 65802 Telephone: (800) 888-0823
Direct Contact:	Karen Bailey 10621 West 98th Street Overland Park, Kansas 66214 email: kbailey@viatechpub.com Telephone: (913) 894-9699 Fax: (913) 894-2505
Binder-Type:	Swing Hinge C78 Split Prong
Construction:	Stiff Binder Board
Covering:	Supported Vinyl, Skytogen Liner

IP7011610

Binding	
Color:	Black
Imprinting:	Foil Stamp in Accordance with Drawing Bound at End of this Division. Imprinting Color: Gold
Capacities Available:	Split Prong, Swing Hinge 2 Inches or 3 Inches as Required

Binder capacities shall not exceed 3 inches, nor shall material included exceed the designed binder capacity. If material to be bound exceeds capacity rating, multiple volumes shall be furnished. Binder capacity should not be more than approximately ½ inch greater than the thickness of the material within the binder.

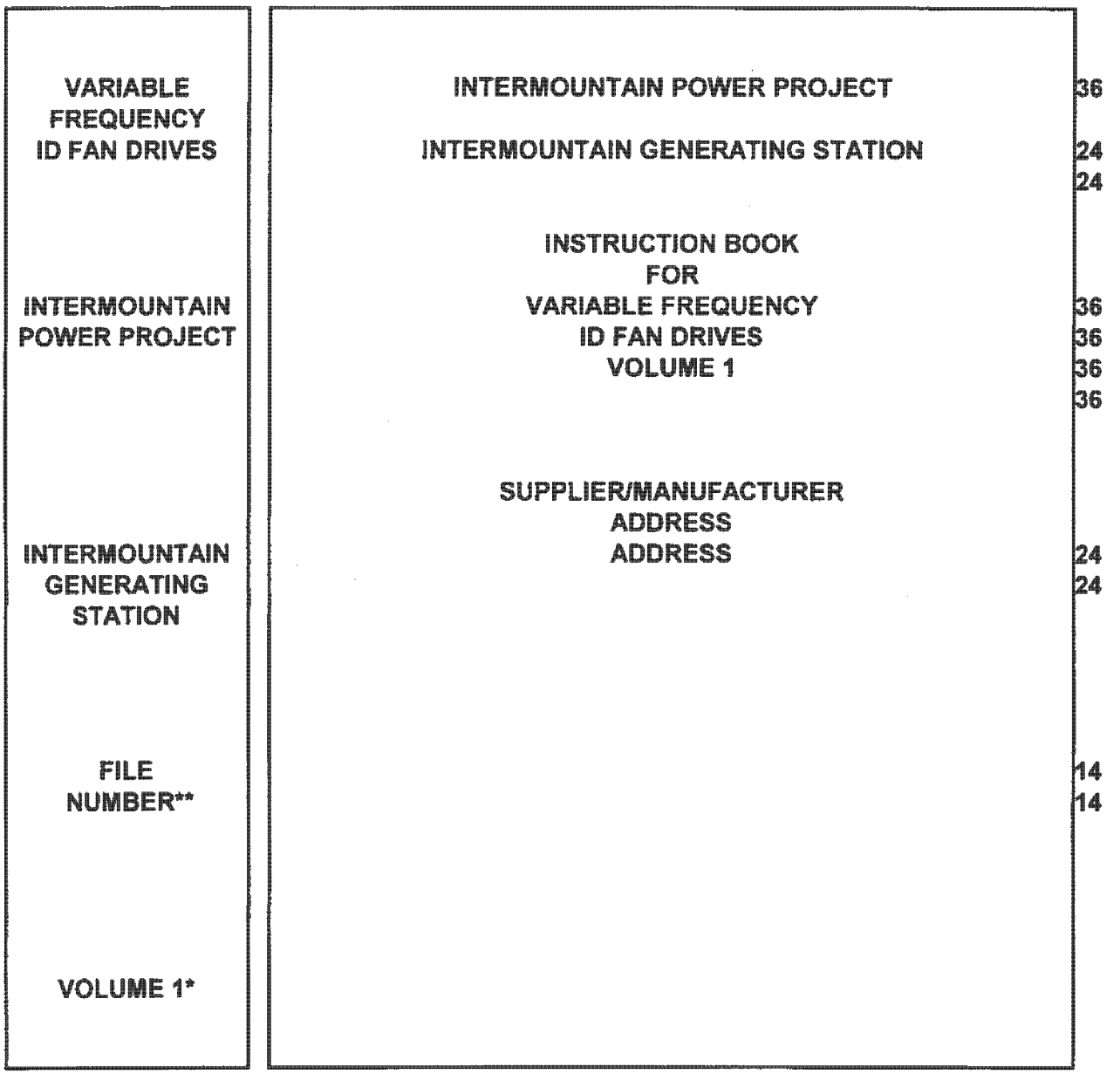
c. Submittal: One (1) complete "proof copy" of the proposed manual(s) shall be submitted to IPSC for review. IPSC's review will be for general conformity to specified requirements and is not intended to constitute detailed review of content.

The copy submitted for review shall be complete with binder; however, to expedite the manufacture and shipment of the binders, the binder supplier may contact IPSC directly to secure acceptance of the binder and its imprinting on the basis of the supplier's layout drawing. This will enable manufacturer to proceed without requiring the submittal of a binder proof copy.

Upon acceptance of the manual by IPSC, Contractor shall distribute the remaining copies to the addresses designated by IPSC. Separate manuals shall be provided for each of the two (2) units.

IP7011611

TYPICAL INSTRUCTION BOOK COVER



(Backbone) (Cover)

Notes:

1. All imprinting shall be "News Gothic" style font.
2. All backbone imprinting shall be 14-point.
3. Cover imprinting shall be point sizes indicated in column to right of cover illustration.
4. *Volume number required only if instructions are contained in more than one (1) volume.
5. **IPSC assigned file number.

IP7011612

PART F - DIVISION F5

GENERAL QUALITY SYSTEM REQUIREMENTS

1. Purpose/Scope: The purpose of this supplemental document to the Technical Requirements is to establish a set of requirements pertaining to the quality of supplied equipment and commodities. Contractor's quality system requirements shall be in accordance with documentation provided in Contractor's bid proposal (Attachment 3).

2. Quality System: It is the responsibility of Contractor to define and implement a detailed and documented quality management system which ensures that all equipment and commodities supplied are in conformance with required drawing and/or specifications and which meets all the guidelines (requirements) set forth in this document. The system shall be capable of providing assurance that design, purchasing, materials, manufacturing, examination, and testing of equipment, shipping, storage, and related services comply with the requirements of the Contract.

   Contractor quality system shall include, at a minimum, procedures or methods to ensure that the following are controlled:

Design documents , drawings, specifications, quality assurance procedures, quality records, inspection procedures, inspection and test status, and Contract Documents maintained current, accurate, and under control.
Purchased materials, equipment, and services conform to the requirements of the Contract.
Receipt inspection, in-process inspection, examination, testing, and checkouts conducted.
Shipping, storage, and preservation of equipment and commodities supplied meet Contract requirements.
Adequate inspection of subcontracted work.
Control of special processes such as welding, heat treating, hot forming, and nondestructive testing.
Proper methods employed for the qualification of personnel who are performing special processes: Welding, nondestructive examinations, coatings, etc.
Inspection, measuring, and test equipment.
Procedures that document and control the verification, storage, use, and maintenance of customer supplied product provided for incorporation into manufactured equipment or commodities.
Any applicable commercial standards (such as ANSI, AGMA, API, ASME) should also be incorporated into this system. This system shall be made available to IPSC's Technical Services Department for review upon request.

IP7011613

3. Quality System Manual: The quality system shall be documented in a quality system manual. One (1) controlled copy of the quality system manual shall be submitted to the IPSC's Contract Administrator's. The quality system manual shall be kept current by submittal of revisions as applicable throughout the life of the Contract.

4. Subcontractor(s): Contractor shall notify IPSC in writing prior to the award of Contract of the intention to use subcontractors. If, at the time of award of Contract, the prime Contractor does not know the name of the subcontractor(s), the prime Contractor's shall provide the name, type, and location of the subcontractor(s) and the Contractor's subcontractor(s) qualification documentation prior to award of subcontractor's work.

   Contractor shall ensure that subcontractor(s) have the capabilities to fulfill the Contract requirements. Contractor shall submit objective evidence of subcontractor(s) capabilities, processes, or in-process work involving the fabricating and manufacturing of equipment and commodities for IPSC.

   Subcontractor(s) qualification and monitoring are the responsibility of Contractor, in accordance with this supplemental specification, to ensure the same high-quality standards. When deemed necessary, IPSC has the authority to perform quality audits and inspections, and monitor and/or review subcontractor(s) processes and facilities.

5. Inspections by IPSC: IPSC may elect to perform inspections, quality audits, or witness testing at any time during the manufacturing process. IPSC may designate an authorized agent for inspections, witness testing, or quality audits. Authorized agent can be an employee of IPSC or an outside agency. When an outside agency is designated as an authorized agent for IPSC, such designation will be in writing with a copy provided to Contractor. Hereinafter, when an IPSC representative is used, it may also mean IPSC or the authorized agent.

   The following requirements shall apply for IPSC's inspection of Contractor's mill, factory, yard, or warehouse.

   a. Inspection and Test Plan: In accordance with the Division F2, Schedule of Submittals, a detailed inspection and test plan (i.e., a Quality Assurance/Quality Control Plan) for the Work shall be submitted to IPSC as specified in the Contract. The inspection and test plan is a detailed step-by-step list of operation and requirements which shall identify the inspection and testing points for major components of the Work and shall be maintained current throughout the Contract. The plan shall include Contractor's strategy for inspecting subcontractor's work, including inspection by Contractor at subcontractor's facilities. IPSC will designate any test witness points or other inspection points required.

   b. Access: IPSC will have the right to inspect Contractor's and subcontractor's Work and related documents in the course of manufacture providing no delays in manufacture are caused thereby. Contractor is required to provide, at its own

IP7011614

expense, reasonable facilities including tools and instruments for demonstrating acceptability of the Work.

c. Test Witnessing: If called for in the Contract and when designated as a hold point, witnessing of mill or factory tests must be performed in the presence of IPSC's Contract Administrator unless waived in writing by IPSC's Contract Administrator. Contractor shall bear all expense of such tests except the compensation and expense of IPSC's representative.

Contractor shall inform and notify IPSC at least ten (10) working days in advance of the appropriate times of inspections and tests, when such inspection and test points have been designated as required hold points for witnessing. The Work shall not progress past a required inspection and test point until IPSC has inspected the Work or witnessed the designated test, or waived in writing the right to perform an inspection or to witness a test.

d. Corrective Action: Upon detention of a noncompliance with the requirements of the Contract or Contractor's quality system, Contractor shall document the noncompliance issue and provide IPSC's representative a copy of the report. If Contractor does not document the noncompliance, then IPSC's representative shall issue a corrective action report to Contractor. Contractor will be required to correct, in a timely manner, all deficiencies identified.

e. Rejection: If any items or articles are found not to meet the requirements of these Specifications, the lot, or any faulty portion thereof, may be rejected. Before offering specified material or equipment for shipment, Contractor is required to inspect the material and equipment and eliminate any items that are defective or do not meet the requirements of the Contract. The fact that materials or equipment have been previously inspected, tested, and accepted does not relieve Contractor of responsibility in the case of later discovery of flaws or defects.

6. Receipt Inspection: Materials or equipment purchased under the Contract may be inspected at the specified receiving points and will either be accepted or rejected. Inspection will include the necessary testing for determining compliance with these Specifications. All expense of initial acceptance tests will be borne by IPSC. The expense of subsequent tests, due to initial test failures, will be charged against Contractor.

IP7011615

PART 6 - DIVISION F6

SEISMIC DESIGN REQUIREMENTS

1. General: This Division specifies the general criteria and procedures that shall be used to ensure that structures, systems, and components will meet their performance objectives during and following a seismic event.

2. Seismic Loads: Seismic loads shall be determined in accordance with applicable portions of Chapter 16, Sections 1613 to 1622 of the 2000 IBC Code. The VFD equipment is being erected in a seismically active area. The importance factor (I_E) shall be 1.5. The site class shall be "D". The spectral response acceleration at short period "S_s" shall be equal to 0.50g and the spectral response acceleration at one (1) second period "S_1" shall be 0.15g. The seismic use group shall be III.

   Contractor shall submit the seismic design calculations for review. These calculations shall indicate all assumptions and references used, and shall be subject to audit to verify that the design is in compliance with these Specifications.

3. Certification: Seismic drawings, calculations, and documentation shall be stamped by a licensed professional engineer.

IP7011616

PART F - DIVISION F7

MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVES

1. General: This Division specifies requirements for VFDs for large 3-phase synchronous or squirrel-cage induction motors. Both current source LCIs and PWM drives are being considered.

To the extent possible, considering the application is a retrofit application, the intent is to purchase the suppliers standard equipment with needed available options. Alternate configurations will be considered. If existing synchronous motors are used, two (2) VFDs, complete with all required control components, shall be furnished for each motor. If new motors are provided, one (1) drive per motor is needed. The Project requires VFDs for eight (8) ID fan motors.

VFDs shall be manufactured and completely assembled.

The VFDs shall be housed in the existing control building along with any associated cooling equipment. Contractor shall include in the Proposal the expected and maximum heat loss on a per drive basis for the VFD proposed.

Rated Capacity	10,000 HP per Fan at 1050 RPM and 8,200 HP per Fan at 954 RPM
Quantity	VFD Systems for Eight (8) Fans Total Over the Next Four (4) Years
Application	ID Fan Service
Input Voltage	Existing Transformers - 6,900 to 3,876 Volts (See Nameplate)
Nominal Frequency	60 Hz
Short-Circuit Current at Point of Common Coupling	32 kA at 6,900 Volts Symmetrical (Maximum)
VFD Equipment Enclosure	NEMA 1
Ambient Temperature	0°C to 50°C (Non-Freezing)
Speed Range	Existing 0 to 954 RPM, 0 to 1050 RPM

a. Coordination: The design of each VFD shall be coordinated with the design of the electric supply and driven equipment. Contractor shall be responsible for furnishing each VFD, for matching the motor and the drive, and for coordinating the collection of data and the design effort to limit harmonics to the specified

IP7011617

levels. Contractor shall be knowledgeable of the requirements specific to the loads that are powered by each VFD. Applicable VFD system options, unique to the load-type, shall be provided.

b. Nameplates: All devices mounted on the face of each drive shall be provided with suitable nameplates. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate. All other devices shall have an engraved, phenolic laminated plate, with black lettering on a white background.

c. Instruction Manuals: In addition to requirements indicated in Division F4, Engineering Data, Article 9, Instruction Manuals, for each size of VFD shall be furnished and shall include the following:

(1) Contractor's standard manuals for each size and type of bypass switch, output contactor, transformer, line reactor, and filter.

(2) Schematics, wiring diagrams, and panel drawings in conformance with construction records.

(3) Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.

(4) Connection data to permit removal and installation of recommended smallest field-replaceable parts.

(5) Information on testing of failed components and an explanation of the drive diagnostics.

d. Codes and Standards: It is desirable that the proposed layout of the equipment be in accordance with standards listed below; however, if due to the equipment sizing, the proposed arrangement cannot comply with any of the standards, Contractor shall list in the Proposal the variation and reason. The equipment shall be provided in full accordance with the latest applicable rules, regulations, and standards of the following:

Codes and Standards
National Electrical Code (NEC)
American National Standards Institute (ANSI)
National Electrical Manufacturers Association (NEMA)
Institute of Electrical and Electronics Engineers (IEEE)
Federal Communications Commission (FCC)

IP7011618

e. Acceptable VFD Systems: Contractor shall be able to demonstrate at least ten (10) years experience in manufacturing VFDs at medium voltage, to demonstrate capability to provide parts and service support. The proposed VFD system shall have been commercially available for a period of not less than two (2) years prior to the date of Contract award. Contractor shall provide at least three (3) sites and names of individuals that may be contacted in the Proposal where similar equipment has been retrofitted.

f. Experience: It is the intent of these Specifications to purchase dependable and reliable equipment offering the best performance available from current proven technology. All equipment furnished under the Contract shall, therefore, have documentation showing proof of actual operation for a minimum of two (2) years in similar service. It is also the intent of these Specifications to procure Contractor's standard system with any options required to meet these Specifications. However, any deviations from these Specifications shall be clearly identified in the Proposal Section as exceptions.

2. Performance: Each VFD system for a fan motor shall be capable of 10,000 HP output at 0.9 per unit input voltage to the VFD. Each VFD shall also be designed and constructed to meet the required performance as specified in the following:

a. Operating Envelope: Each VFD shall meet the following speed and torque requirements.

Each drive shall provide a turning gear speed of 10 percent speed. Contractor shall verify the minimum speed of 10 percent is acceptable to the motor vendor.

Each VFD shall be capable of producing a variable AC voltage/frequency output to provide continuous operation over the speed range of 10 percent to 1050 RPM. Drives shall include a software setable maximum speed limit. Each VFD shall be capable of sustained operation at 1/10 speed to facilitate checkout and maintenance of the driven equipment. As a commissioning and troubleshooting feature, each VFD power circuit shall be capable of operating without a motor connected to a VFD output.

Each VFD shall be capable of operating any synchronous AC motor of equivalent rating (horsepower and speed) over the specified speed range. Each VFD shall be rated to power the motor continuously at the motor's rated nameplate horsepower multiplied by the service factor.

The controls in each VFD shall provide an adjustable maximum horsepower limit so the drive output can be matched to the existing motor (if being reused) or to a larger motor (up to 10,000 HP).

IP7011619

The drive shall be capable of giving an overload torque of 105 percent of full-load torque.

b. Operating Range: Each VFD system shall be designed to enable fan operation over the entire operating range defined on the speed-torque curve shown in Figure 3.3, page F7-20, located at the end of this Division.

c. Input Harmonics: VFDs input harmonics shall comply with the latest edition of IEEE 519-1992 for total harmonic voltage and current distortion limits:

(1) Voltage Harmonics: Individual or simultaneous operation of the VFDs shall not add more than 5 percent total harmonic voltage distortion while operating from the utility source.

(2) Compliance: Compliance shall be verified by Contractor with field measurements of harmonic distortion differences at the point of common coupling with and without VFDs operating. The Point of Common Coupling (PCC) for all harmonic calculations and field measurements for both voltage and current distortion shall be defined as the main breaker feeding the 6,900 volt bus feeding the drive, based on individual motors.

d. Motor Compatibility: Characteristics of the existing ID fan motors are as follows:

Service	ID Fan
Machine-Type	Synchronous
Mounting	Horizontal
Enclosure	NEMA WPII with Filters
Insulation	Class F, Thermalastic
Temperature Rise	75°C
Standards	NEMA and IEEE
Ambient Temperature Maximum	50°C
Altitude Maximum	4,700 Ft Above Mean Sea Level
Duty	Continuous
Rated Output, HP	7,415 HP
Service Factor	1.0
Voltage, Volts/Frequency/Phase	3876 V, 63.6 Hz, 3-Phase

Service	ID Fan
Speed, RPM	954
Current, amps	Two (2) Windings, 472 Full Load Amps Each When Two (2) Windings in Service; With One (1) Winding in Service, 506 Amps
Locked Rotor amps, maximum	N/A
Efficiency, Minimum (Full Load)	97 Percent
Power Factor, Minimum (Full Load)	0.9 Percent
Starting Voltage Range	VFD
Starting Capability	VFD
Running Capability	VFD
Bearings	Sleeve
Bearing Lubrication	Forced Oil, Recirculation-Type; Each Bearing Requires 2.5 GPM at 20 Psig
Temperature Detectors	One (1) Type E Thermocouple per Bearing; Two (2) 10 OHM Copper RTDs per Winding
Windings	Copper
Vibration Detectors	Mounting Only
Terminal Box	Two (2) per Motor, Includes Three (3) Neutral Current Transformers
Space Heater	Yes
Sound Level	85 dB at 3 Ft in Accordance with IEEE 85
Tests	Copies Will be Made Available for Review
Incoming Cable	Shielded Cable in Conduit
Current Transformers	If Required

IP7011621

Service	ID Fan
Surge Capacitors	No
Lightning Arresters	No

If the existing motors are used, each VFD system shall provide an output waveform suitable for the existing motors. Contractor shall verify equipment will not be detrimental to the motor life expectancy, which shall not be compromised in any way by operation with a VFD system. Each VFD shall provide motor overload protection in any operating condition.

The system design shall not have any inherent output harmonic resonance in the operating speed range.

Each VFD output shall be tuned to minimize electrically induced pulsating torque to the output shaft and the mechanical system. Contractor shall be responsible for damage to the existing motor, coupling, and fan due to torque pulsations. Contractor shall repair and/or replace items damaged at no cost to IPSC. Existing input transformers and reactors may be used if adequate for the service. New transformers and reactors shall be provided if existing transformers and reactors are not adequate.

e. VFD System Efficiency: Guaranteed minimum total VFD system efficiency (ηsys) shall be a minimum of 99 percent at 100 percent speed and 100 percent load, and a minimum of 95 percent at 80 percent speed and 50 percent load. Efficiency evaluation shall include input transformer, harmonic filter, power factor correction (if applicable), VFD converter, and output filter, as indicated below. Auxiliary controls, such as internal VFD control boards, cooling fans, or pumps shall be included in all loss calculations.

The efficiency of a VFD system shall be calculated as follows:

ηsys = ηVFD x ηxfmr x ηpfc x ηharm x ηfilt	
Converter/Inverter (VFD)	ηVFD
Input Transformer	ηxfmr
Power Factor Correction	ηpfc
Input Harmonic Filter	ηharm
Output Filter	ηfilt

IP7011622

Total VFD system efficiency (ηsys) shall be 96 percent at full load and 95 percent at 50 percent load.

A penalty ($1,275 per kW) shall be assessed if efficiency is not achieved and shall be deducted from the Contract price.

Drive efficiency evaluation and calculations shall be made in accordance with IEEE 995-1987 Section 5.3.5 at the dual channel rating point of 7,415 HP, 954 RPM, 3,876 V with 4,031 V, 60 Hz supply.

f. System Input Power Factor: Each VFD system shall maintain a power factor in accordance with Attachment 3. A penalty ($50 per kVAR) shall be assessed if power factor is not achieved and shall be deducted from the Contract Price.

The power factor shall be measured in accordance with the following requirements:

(1) Total 12-pulse power factor is measured — this will require that the power drawn by two transformers, and only two transformers be measured together (for one drive.)

(2) The supply voltage shall be at its nominal value of 6.9 KV for the duration of the testing.

(3) The drive is to be fully adjusted for optimization.

(4) Adjustments are allowed to correct for any deviation.

(5) A margin of error +/- 2 percent is to be permitted on readings.

(6) Readings shall be made by visual comparison of phase current of voltage waveforms to obtain the apparent power factor as defined in Alstom bid ref: SAD00149 dated September 4, 2003.

(7) To conduct the test, it must be permitted to increase the motor voltage by at least 5 percent as described in Alstom bid ref: SAD00149 dated September 4, 2003.

(8) It must, also, be possible to tap down the supply transformer(s) in order to achieve firing angle optimization as described in Alstom bid ref: SAD00149 dated September 4, 2003.

(9) The evaluation is made at fan speed of 800 RPM.

(10) The target power factor is 0.88 at 800 RPM (penalty assessment point.)

g. Speed Control System: The speed control system shall be designed to be compatible with the IPSC-furnished plant control system. The speed control system, shall also be in accordance with the paragraphs which follow.

The speed control system shall provide linear speed control corresponding to IPSC-furnished 4-20 mA (linear from 0 to 100 percent) speed control signal. Dynamic speed control range shall be 0 to 100 percent. Steady-state speed control range shall be 10 to 100 percent. The speed control shall be capable of setting the motor speed to an accuracy of plus or minus 1 percent of the test block speed of the fan.

A change in IPSC-furnished speed control signal shall not initiate a drive system acceleration or deceleration torque command unless the IPSC-furnished speed control signal changes by a field adjustable amount.

The range of this field adjustable amount shall be from plus or minus 0.5 percent to plus or minus 5 percent of full speed.

The speed control system shall be inherently stable when the IPSC-furnished speed control signal is in a steady-state condition. The speed control system shall automatically adjust rectifier SCR firing to maintain motor speed to compensate for motor load changes and 6,900 volt bus voltage changes. Changes in motor load and 6,900 volt bus voltage shall not initiate acceleration or deceleration torques. Steady-state speed control shall be within plus or minus 1 rpm without encoder or tachometer feedback.

It is expected that during starting of other large motors, the 6,900 volt bus voltage will drop momentarily to as low as 5,400 volts. This condition shall not affect motor speed as long as sufficient current, up to current limit, is available in relation to supply voltage to maintain motor speed. If insufficient current is available to maintain drive speed, the current applied shall be the current limit. The speed control system and all components of the ID Fan Variable Frequency Drive shall be capable of sustaining this condition for a minimum of 30 seconds after which coasting of the motor will be permitted. Normal control shall be initiated as soon as the 6,900 volt bus voltage reaches 6,600 volts. Speed control should resume once motor is out of current limit.

During certain times the input voltage will drop to 70 percent of its rating, motor coasting shall be initiated. Normal control shall be initiated as soon as the 6,900 volt bus voltage reaches 6,600 volts.

The electric adjustable speed drive systems shall be suitable for continuous operation at turning gear speed for equipment cool-down. Proposed information shall describe operation at turning gear speed.

IP7011624

h. Sound Level: Maximum allowable audible noise from a VFD system shall be 75 dB(A) at a distance of 1 meter (3.3 feet) at any speed or load condition. VFD systems with audible noise in excess of the limit shall be provided with sufficient noise abatement treatment to reduce the sound pressure level below 75 dB(A).

3. Design Calculations:

a. Torsional Analysis: The price of a torsional analysis shall be included in the base price. A deduction shall be included in case IPSC chooses not to have a torsional analysis. The total rotating system shall be analyzed to determine its natural resonant frequencies. Stresses shall be calculated for elements of the rotating system, utilizing torsional excitation data from the drive and driven system, taking into account potential fault conditions and appropriate amplification and damping factors of the rotating system. A written report on the analysis, which details the procedures used and the assumptions that were considered, shall be provided. The results of the analysis shall be presented in both detailed and summary form. Specific data presented shall include the following:

(1) A diagram of the frequencies of the torque pulsations and the mechanical resonant frequencies showing the coincident points.

(2) A plot of total shaft stress versus operating speed for the most highly stressed areas of the rotating system.

(3) A diagram of the rotating system model and mode shapes for resonance(s) of interest.

(4) Tables summarizing total calculated stresses for each element of the rotating system at operating speeds where interference(s) exist between torsional excitations and torsional resonance.

(5) Details of the rotating system used in the analysis, including the specified or a recommended alternate coupling. If a new coupling is required, Contractor shall furnish it.

(6) Recommendations for any modifications to the proposed system, if indicated by the analysis to be advisable, the cost of which shall be borne by Contractor.

b. Harmonic Study: A preliminary harmonic analysis shall be performed. A power system short-circuit ratio of twenty shall be assumed, with all VFDs operating at maximum speed and maximum load. Short-circuit current (ISC) utilized for harmonic analysis calculations is 32,000 amperes.

IP7011625

Contractor shall submit the harmonic analysis at the time of bid, which includes all voltage and current harmonics up to the forty-ninth.

4. Availability:

a. Firing Signals: All internal firing signals, and other communications (which link operational controls with power components such as status and diagnostic signals) shall meet noise immunity and safety requirements as defined by applicable IEEE Standards.

b. Failed Switch Bypass/Ride-Through Capability: The failure of any power switching device (SCR, GTO, diode, IGBT, IGCT, etc.) or switching device control shall not result in a process trip and shall allow for continued operation of each VFD system. Either N-1 or cell bypass is acceptable. In the event of a device or device control failure, a VFD shall annunciate and identify the specific location of the failed device and allow for continued operation until such time as repairs can be scheduled. The failure of any power switching device (SCR, GTO, diode, IGBT, IGCT, etc.) or switching device control shall not result in a channel trip and shall allow for continued operation of each VFD system with both channels in service. If one (1) channel does trip, Contractor shall state this in the Proposal.

c. Power Interrupt Ride-Through: Each VFD system shall be capable of continuous operation in the event of a power loss of 5 cycles or less.

Each VFD system shall be capable of automatically restarting in event of a loss of power. Each VFD system shall provide IPSC with the choice of automatically restarting or not. IPSC will be able to selectively apply this feature and have the ability to set the allowable restart time applicable to some (but not necessarily all) conditions as determined by IPSC to be appropriate for the specific application.

d. Power Sag Ride-Through: Each VFD system shall be capable of continuous operation with a 30 percent voltage sag on the input power line.

e. "Catch-A-Spinning-Load" Capability: Each VFD system shall be able to catch and take control of a spinning load if started while rotating equipment is already spinning. Appropriate safeguards shall be included in this operation to prevent damaging torque(s), voltages, or currents from impacting any of the equipment. IPSC shall have the option of employing this feature or disabling it.

f. Auto Restart Capability: Each VFD system shall be capable of automatically restarting in the event of an undervoltage trip. Each VFD system shall provide IPSC with the choice of automatically restarting or not. IPSC shall be able to selectively apply this feature to some (but not necessarily all) conditions as determined by IPSC to be appropriate for the specific application.

g. Ground Fault Withstand: In the event of a ground fault, a VFD shall be capable of annunciating the ground fault condition, safely operating and, by IPSC selection, either trip or continue operation. As a result of a ground fault trip, a VFD shall be capable of being reset and begin operating normally again after the ground fault condition has been corrected. There shall be no risk of fire or electric shock as a result of the ground fault.

5. Serviceability/Maintainability:

a. Front Access: It is preferred that each system of channel be designed for front access only. Contractor shall state in the Proposal if rear or side access is required. An explanation of reason for any required rear or side access shall be given.

b. Power Component Accessibility: All power components in the converter sections shall be mounted on a swing frame or rack-out for ease of maintenance and to minimize repair downtime. Alternate access options shall be described in the Proposal for the IPSC Contract Administrator's review and evaluation.

c. Voltage Isolation: All low voltage components, circuits, and wiring shall be separated with physical barriers from any sources of medium voltage.

d. Marking/Labeling: Sleeve-type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual nameplates shall be provided for all major components of a VFD system.

e. Mean Time to Repair (MTTR): The VFD design shall demonstrate an actual mean time to repair of less than 15 minutes in the event of any power switching component failure. The mean time for replacement of power switching components shall be based on replacing a thyristor module.

6. Physical Requirements:

a. Environmental Requirements: Each VFD system shall be capable of continuous operation in an average ambient temperature between 0°C and 50°C at an elevation up to 4,700 feet above mean seal level without derating. Each VFD system shall also be simultaneously suitable for continuous operation in a maximum humidity between 0 and 95 percent non-condensing.

b. Heat Dissipation/Cooling System: Each VFD system shall be liquid-cooled. Contractor shall furnish the heat exchangers and all mounting material and hardware to accommodate the exchangers.

c. Liquid-Cooling Requirements: Liquid cooled VFDs shall be provided with 100 percent redundant pumps with automatic switch over in the event of a pump

failure. Redundant systems shall be provided so a pump can be taken out of service for maintenance or repair without taking a drive out of service.

A minimum of 90 percent of the heat generated (losses) by the drive system shall be removed through the liquid cooling system. Contractor shall provide heat dissipation data necessary to design all auxiliary cooling systems and utilities. The system shall be designed so a failed pump can be safely isolated and repaired while a VFD system remains in service. Cooling pump motors shall have sealed bearings for a long, maintenance-free life.

Liquid-to-liquid heat exchangers shall be furnished by Contractor. IPSC will furnish piping, power, and control wiring between each VFD and IPA-furnished water supply of 50 percent glycol. The cooling system shall be filled following installation of the drive. Coolant liquid shall be furnished by Contractor.

The cooling system shall consist of two (2) circuits. One (1) internal circuit where deionized water is used and one (1) exterior circuit where propylene glycol is used to provide an ambient service temperature range of -35°C to 50°C. Ethylene glycol is NOT acceptable due to environmental and hazardous material concerns.

Quick disconnect fittings shall be provided at each connection between the header and the supply hose in the drive.

Dissimilar metals shall be completely avoided in cooling liquid piping. The use of threaded connections shall be minimized. All connections and fittings shall be designed based upon the system cooling fluid and the required flow, and shall be tested at two (2) times the normal system design operating temperature and pressure.

Each VFD cooling system shall maintain system coolant temperature within a safe minimum and safe maximum temperature to avoid thermal shock and/or condensation.

d. Enclosure: All VFD system components, including transformer (for PWM drives), shall be mounted and wired by Contractor in a grounded enclosure meeting the following requirements without exception.

Input filters, transformer, power conversion, output filters and auxiliary equipment enclosure sections shall be NEMA 1A gasketed design. Microprocessor and control logic boards and power supplies shall be housed in NEMA 1A gasketed section, safely accessible without exposure to high voltages and without drive shutdown. All low voltage wiring shall be fully isolated from medium voltage compartments by metal barriers.

Cabinets and doors shall be fabricated using heavy gauge steel (12 gauge minimum) for sturdy construction and dimensional integrity to ensure long-term fit and function. All doors shall be gasketed to provide environmental protection and secure fits.

Enclosures shall be designed to avoid harmonic and inductive heating effects. The enclosure shall be designed to shield any outside equipment form interference, enclosing, and shielding the complete component to eliminate any radio frequency interference in compliance with FCC Part 18 requirements.

e. Installation/Cabling: IPSC will set the VFD equipment in place and install interconnecting wiring. Contractor's Proposal shall include a detailed description of installation requirements.

f. Space Limitation - Footprint: Contractor shall provide a proposed layout of equipment with the Proposal. Floor plans of all existing control buildings are included.

g. Door Handle Locks: Cabinets shall be provided with lockable door handles. Locking shall be fully coordinated to prevent access to all high voltage compartments, including transformer, filters, or any switchgear that is part of the supply, when line power is applied to each VFD system. Locks shall provide positive lockout prevention and safety. Electrical interlock switches alone are not acceptable due to the possibility of inadvertent shutdown and the ease with which such switches could be bypassed.

h. Control Power and UPS System: Contractor's Proposal shall include a detailed description of control and accessory power requirements for the proposed system.

i. Space Heaters: The power/control assembly including individual compartments shall be provided with space heaters to prevent condensation of moisture within the enclosures. The heaters shall be spaced away and thermally insulated from any painted surfaces.

Space heater capacity shall be as required to maintain the compartment internal temperature above the dew point.

Voltage normally applied to the space heaters is 120 volts AC. Space heater voltage rating shall be 120 volts AC.

IPSC will provide a 2-wire, 120 volt, 60 hertz space heater supply feeder to each assembly. Contractor shall provide all required internal wiring and suitable branch circuit protection for each space heater circuit.

All space heaters shall be controlled by an adjustable thermostat, factory set to close at 85°F (ON) and to open at 95° F (OFF).

7. Protective Devices/Diagnostics:

a. Power Component Protection: Each VFD system shall include protection to the converter rectifier devices to protect the secondary of the transformer from any potentially harmful fault currents. Arrangements that involve coordinated protection with an input circuit breaker are not as desirable and, if proposed, Contractor shall furnish all coordinating elements, including the circuit breaker and a detailed description of the protection scheme with the Proposal.

b. Protective Features and Circuits: The controller shall include the following alarms and protective features:

Alarms and Protective Features
Static Instantaneous Over-Current and Over-Voltage Trip
Under-Voltage and Power Loss Protection
Over-Temperature Protection
Electronic Motor Inverse Time Over-Load Protection
Motor Over Speed

Each VFD system shall be protected from damage due to the following, without requiring an output contactor:

1-Phase Fault or 3-Phase Short Circuit on VFD System Output Terminals
Failure to Commutate Inverter Thyristor Due to Severe Overload or Other Conditions
Loss of Input Power Due to Opening of VFD Input Disconnect Device or Utility Power Failure During VFD Operation
Loss of 1-Phase of Input Power

c. Data Displays: A door-mounted LCD display shall be furnished, capable of displaying VFD operational status and drive parameters. The digital display shall present all diagnostic message and parameter values in plain language engineering units when accessed, without the use of codes.

IP7011630

As a minimum, the following door-mounted digital indications shall be supplied:

Door-Mounted Digital Indications
Speed Demand in Percent
Actual Speed
Input Current in Amperes
Output Current in Amperes
Output Frequency in Hertz
Input Voltage
Output Voltage
HMI
Horsepower Meter
Elapsed Time Running Meter

d. Diagnostics and Fault Recording: The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors.

Fault log data storage memory shall be stored in nonvolatile memory or be supported by a UPS size to provide a minimum of 48-hour data retention. Each VFD shall include a comprehensive microprocessor based digital diagnostic system, which monitors its own control functions and displays faults and operating conditions.

A '*Fault Log*' shall record, store, and display, upon demand, the following for the fifty (50) most recent events:

Fault Log
VFD Mode (Auto/Manual)
Date and Time of Day
Type of Fault
Reset Mode (Auto/Manual)

A '*Historic Log*' shall record, store, and display, upon demand, the following control variables at an adjustable time interval for the fifty (50) intervals

IP7011631

immediately preceding a fault trip and one-hundred (100) intervals following such trip:

Historic Log
VFD Mode (Manual/Auto/Inhibited/Tripped/Etc.)
Speed Demand
VFD Output Frequency
Demand (Output) Amps
Feedback (Motor) Amps
VFD Output Volts
Type of Fault
Drive Inhibit (On/Off)

The fault log record shall be accessible via a RS232 link.

A "Windows 95" or newer based graphical tool suite shall be provided with the VFDs. This graphical PC tool shall be able to plot and display **up to eight (8)** different VFD parameters and have the ability to freeze plotting and print hard copy versions of the plots. Capability to display at least eight (8) different VFD system parameters is required, and all parameters displayed on the PC tool shall be synchronized with the standard keypad display.

8. Programming and Communications:

a. User Input/Keypad: The door of each unit shall include a HMI plus a 9-pin programmer port, a red '*Drive Running*' light, a green '*VFD Healthy*' light, and a reset button.

An internal keypad with integral digital LCD display shall be furnished, capable of controlling a VFD and setting drive parameters. The display shall present all diagnostic messages and parameter values in standard engineering units when accessed, without the use of codes. A plain language user menu (rather than codes) shall be provided in software as a guide to parameter setting, accessible via the programming port.

Drive parameters shall be factory set in non-volatile battery backed-up RAM registers and resettable in the field through the keypad. Multiple levels of password security shall be available to protect drive parameters from unauthorized personnel. The battery backed-up RAM stored drive variables shall

IP7011632

be able to be downloadable for programming of new or spare boards. Systems shall allow programming changes while in service.

Each VFD system shall have the user selectable option of programming up to three (3) speed avoidance bands. This gives the user the ability to block out and prevent operation at any undesirable speed, such as one (1) that may be coincident with a mechanical resonance condition.

b. Hard-Wired Communication: Contractor shall provide five (5) additional analogs, ten (10) additional digital inputs, and ten (10) additional digital outputs for connection to IPSC's plant control system for each VFD drive. All trip and start commands from IPSC's plant control system shall be hard-wired. A listing of the existing hard-wired control signals is included at the end or this Division. A copy of the existing schematics will be provided to Contractor after the Contract is awarded. *Note: The number of I/O signals will be agreed to based upon review of approval drawings transmitted on December 2,2003.*

c. Serial Communication/Protocols/Modem or Cable: VFD shall be capable of direct communication to an IBM or compatible computer via digital link fiber-optic link for setup of parameters, fault diagnostics, trending, and diagnostic log downloading. VFD parameters, fault log, and diagnostic log shall be downloadable for hard copy printout via the digital fiber-optic link to a standard serial printer connected to the computer.

Each VFD shall be provided with single port digital communication capability to allow status communication with the IPSC plant control system. Modbus communication protocol shall be provided.

9. Component Requirements:

a. Printed Circuit Boards: All printed circuit boards shall be new and coated for moisture and chemical resistance, in addition to, any dielectric coating properties. All boards shall be tested in accordance with Division F2.

b. Power Bus and Wiring: Main power bus shall be high-conductivity copper and plated for chemical and corrosion resistance and low losses. The bus shall be appropriately sized for the VFD continuous current rating and braced to withstand the mechanical forces caused by a momentary short-circuit current of 32 kA at 6900V. All connections shall be bolted or continuously welded.

c. Ground Connection: Corrosion-resistant grounding pads shall be provided in each power cubicle. A copper ground bus shall be provided for grounding of control circuits.

IP7011633

d. Input Power Terminations: Input and output power connections shall be made to isolated, supported, and plated bus strap connections. Sufficient space shall be provided for termination connections from the bottom of each VFD cubicle. Space provisions shall be provided for application of standard stress cones, and provisions shall be provided for grounding of shielded cabling.

10. Output Contactor or Switchgear: Each VFD output section shall contain a suitably rated load break disconnect switch interlocked with the door. The switch shall isolate a VFD for maintenance and service. For safety, blade position shall be visible through the door. The disconnect switch shall be free standing and next to each VFD system so as to appear as a single integrated package. The switch shall be electrically interlocked with a contact from the drive input circuit breaker to prevent the switch from changing positions while the input circuit breaker is closed. The switch shall consist of dead front, completely metal enclosed vertical sections containing isolation switches or breakers. The door shall be interlocked with the switch so that: (a) The switch must be opened before the door can be opened; and (b) The door must be closed before the switch can be closed. There shall be a provision for padlocking the switch in either the open or closed position. The switch shall have permanent "open" and "closed" switch position indicators. The switch shall have a quick-make, quick-break mechanism providing isolation. Insulating barriers shall separate each phase and between the outer phases and the enclosure. All switches shall comply with ANSI C37.20.3, ANSI C37.22, ANSI C37.57, ANSI C37.58, NEMA SG5, and UL Standards.

11. Testing: A no load test shall be performed on the system. The drive shall be connected to an unloaded motor and feed back signals shall be verified. Output voltage shall be calibrated. All logic and interlocks, including customer logic and instrumentation, shall be tested.

The drive shall be given a full power test at rated current and rated voltage (simultaneously) for a minimum of four (4) hours (or until all system temperatures stabilize, whichever is longer). The test shall be performed as an integrated system, including all supplied input switchgear, input transformer, input filter (if supplied), power section, and output filter (if supplied). Contractor shall perform the system test to verify total system efficiency, power factor, and harmonic distortion limits are met as specified. After installation of drives, total system efficiency shall be measured using watt meters or Multilin PQM or approved equivalent meters on both the input and output of the complete system. Certified test data of all tests conducted shall be provided with final documentation.

The testing may be witnessed by the IPSC Contract Administrator. A projected test schedule and a copy of proposed test procedures shall be provided at least one (1) month in advance of test date. The IPSC Contract Administrator shall be given at least one (1) week prior notice or confirmation of actual test date(s).

IP7011634

12. Delivery: The VFD system shall be delivered to the IPP Job Site preassembled and wired with all specified interconnecting wiring and cable. Cabling for connection across shipping splits shall be neatly coiled and identified. Exposed sections of equipment shall be fully protected from damage during shipment. All necessary hardware for reconnecting shipping splits shall be provided.

    Setting equipment in place, aligning, and anchoring will be done by others. Contractor shall supervise all system interconnections across shipping splits at the IPP Job Site. Complete instructions for handling and storage shall be provided prior to delivery of the equipment. All equipment shall have adequate provisions for handling by overhead crane or forklift.

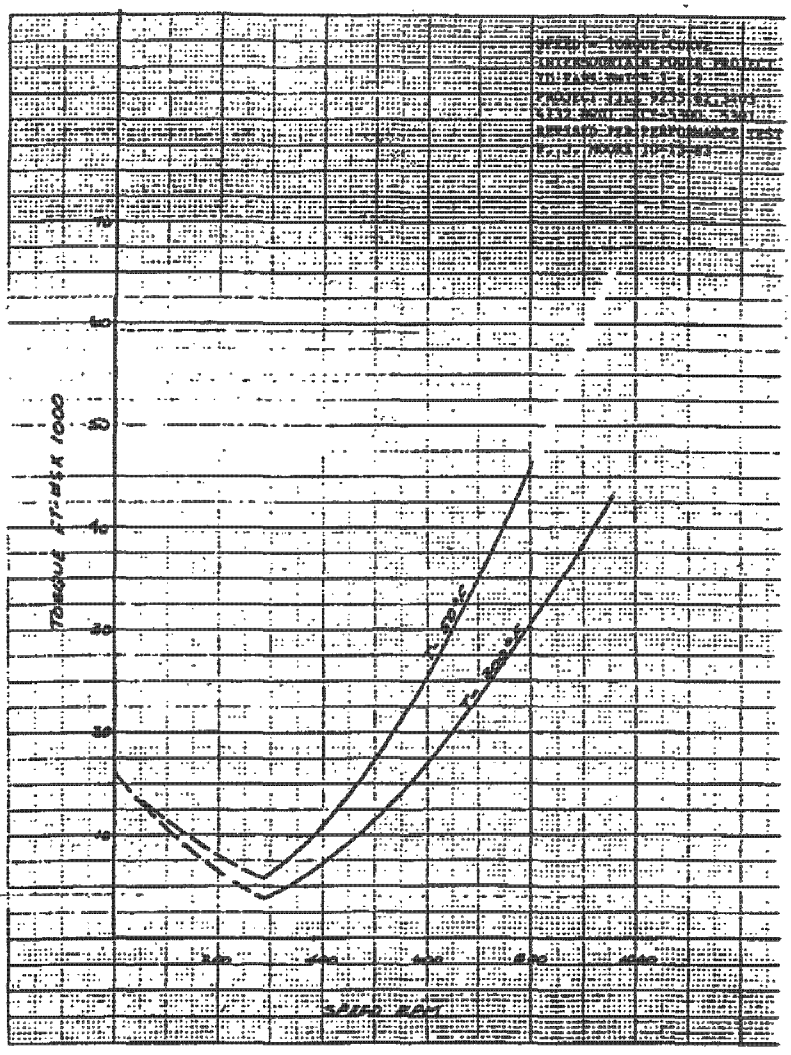
13. Training: Contractor shall provide an on-site training school for IPSC Operations, Maintenance, and service personnel (fifteen [15] total). The training school shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment. Topics covered shall include, safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, software mapping, programming, setup, configuration, control loop tuning, operational indicators, faults, diagnostic tools, troubleshooting, and preventative maintenance. Hands-on training shall be provided on equipment of the same design as the equipment provided. Documentation shall be provided and shall include actual manuals for the equipment and drawings and schematics of equipment supplied for the Project. IPSC reserves the right to video tape all training sessions.

14. Startup: Contractor shall provide the field services of a factory technician as necessary to supervise/inspect installation, test, and startup all equipment provided as part of the fixed price proposal. The firm price shall include all travel and living expenses in addition to the start-up engineer's time required to complete supervision of the installation, testing, and startup as indicated in Division F2. All equipment required for testing, startup, and performance verification shall be provided by the start-up technician. Contractor shall furnish all required start-up spare parts.

    Verification of VFD input harmonic voltage and current distortion limits specified shall be verified at rated speed and rated equivalent power as part of final startup and acceptance. A recording-type Fluke, Multilin PQM, BMI, or equivalent harmonic analyzer displaying individual and total harmonic currents and voltages shall be utilized. For the purpose of harmonic verification to IEEE 519-1992, it is understood that "rated power" and "rated speed" are 7415 HP and 954 RPM respectively. All testing will be conducted in the normal, dual-channel mode of operation.

IP7011635

SYSTEM DESCRIPTION	FILE NO. 9255.93.1405
INDUCED DRAFT (CCE)	IPP 121284-1



INDUCED DRAFT FAN
SPEED-TORQUE CURVE
FIGURE 3-3

IP7011636

Existing Hard-Wired Control Signal List - One (1) ID Fan Variable Frequency Drive						
Note: The hard-wired control signal list will be agreed to based upon review of approval drawings transmitted on December 2, 2003.						
Device	**Type**	**Switch**	**Description**	**Power Source**	**Point Name**	**Signal**
Contactor	DI		Induced Draft Fan Contactor 1A2 Closed	ID Fan 1A Remote I/O Power	10234	120 VAC
Contactor	DI		Induced Draft Fan Contactor 1A1 Open	ID Fan 1A Remote I/O Power	10235	120 VAC
Contactor	DI		Induced Draft Fan Contactor 1A2 Open	ID Fan 1A Remote I/O Power	10233	120 VAC
Contactor	DI		ID Fan Cont 1A1 Disconn Key SW Permit To Close Bkr	Field Power		125 VDC
Contactor	DI		SWGR Power OFF (Green Light)	Field Power		125 VDC
Contactor	DI		ID Fan Feeder Bkr Trip Push Button	Field Power		125 VDC
Contactor	DI		Induced Draft Fan Contactor 1A1 Closed	ID Fan 1A Remote I/O Power	10236	120 VAC
Contactor	DI		ID Fan Feeder Bkr Door Switch	Field Power		125 VDC
Contactor	DI		Swgr Power On (Red Light)	Field Power		125 VDC
Contactor	DI		ID Fan Cont 1A1 Disconn Key Sw Trip Surge Bkr	Field Power		125 VDC
Motor	AI	TE-946	ID Fan 1A Motor Inbd Bearing Temperature			4-20 MA
Motor	AI	TE-681	ID Fan 1A Motor Inbd Bearing Temperature			4-20 MA
Motor	AI	TE-685	ID Fan 1A Motor Outbd Bearing Temperature			4-20 MA

IP7011637

Existing Hard-Wired Control Signal List - One (1) ID Fan Variable Frequency Drive						
Device	**Type**	**Switch**	**Description**	**Power Source**	**Point Name**	**Signal**
Motor	AI	TE-986	ID Fan 1A Motor Winding Temperature			4-20 MA
Motor	AI	TE-942	ID Fan 1A Motor Winding Temperature			4-20 MA
Motor	AI	TE-980	ID Fan 1A Motor Outbd Bearing Temperature			4-20 MA
Motor	DI	TS-603	XFMR 1A1 Temp HI-HI	ID Fan 1A Remote I/O Power	10179	120 VAC
Motor	DI	TS-602	XFMR 1A1 Temp HI-HI	ID Fan 1A Remote I/O Power	10179	120 VAC
Motor	DI	TS-604	1A2 XFMR HI-HI	ID Fan 1A Remote I/O Power	10180	120 VAC
Motor	DI	TS-601	XFMR 1A1 Temp HI-HI	I/D Fan 1A Remote I/O Power	10179	120 VAC
Motor	DI	PS-426	ID Fan 1A Motor Air Filter Diff Press HI	ID Fan 1A Remote I/O Power	10178	120 VAC
Motor	DI	TS-606	1A2 XFMR HI-HI	ID Fan 1A Remote I/O Power	10180	120 VAC
Motor	DI	TS-605	1A2 XFMR HI-HI	ID Fan 1A Remote I/O Power	10180	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A2 Fdr Brkr Closed		10129	
VSD	DI		ID Fan Variable Speed Drive 1A2 Contactor	ID Fan 1A Remote I/O Power	10232	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A1 Turning Gear Speed	ID Fan 1A Remote I/O Power	10225	120 VAC

IP7011638

Existing Hard-Wired Control Signal List - One (1) ID Fan Variable Frequency Drive						
Device	**Type**	**Switch**	**Description**	**Power Source**	**Point Name**	**Signal**
VSD	DI		ID Fan Variable Speed Drive 1A2 Fdr Brkr Closed		10130	
VSD	DI		ID Fan Variable Speed Drive 1A1 Contactor	ID Fan 1A Remote I/O Power	10244	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A1 Zero Speed	ID Fan 1A Remote I/O Power	10227	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A2 Min Speed 150 RPM	ID Fan 1A Remote I/O Power	10226	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A1 Fan Control Run			
VSD	DI		ID Fan Variable Speed Drive 1A2 Zero Speed	ID Fan 1A Remote I/O Power	10227	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A2 Trouble	ID Fan 1A Remote I/O Power	10228	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A2 Fdr Brkr Open		10134	
VSD	DI		ID Fan Variable Speed Drive 1A2 Trngr Spd Command		10131	
VSD	DI		ID Fan Variable Speed Drive 1A2 Norm Sp Command		10132	

IP7011639

Existing Hard-Wired Control Signal List - One (1) ID Fan Variable Frequency Drive						
Device	**Type**	**Switch**	**Description**	**Power Source**	**Point Name**	**Signal**
VSD	DI		ID Fan Variable Speed Drive 1A2 Turning Gear Speed	ID Fan 1A Remote I/O Power	10225	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A2 Ready	ID Fan 1A Remote I/O Power	10231	120 VAC
VSD	DI		ID Fan Variable Speed 1A1 Drive Ready	ID Fan 1A Remote I/O Power	10243	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A1 Reference Failure			
VSD	DI		ID Fan Variable Speed Drive 1A1 Trouble	ID Fan 1A Remote I/O Power	10229	120 VAC
VSD	DI		ID Fan Variable Speed Drive 1A1 Fan Control Off			
VSD	DI		ID Fan Variable Speed Drive 1A1 Min Speed 150 RPM	ID Fan 1A Remote I/O Power	10226	120 VAC
VSD	DO		ID Fan Variable Speed Drive 1A1 Norm Sp Command		00344	
VSD	DO		ID Fan Variable Speed Drive 1A1 Fdr Breaker Open		00345	
VSD	DO		ID Fan Variable Speed Drive 1A1 Fdr Breaker Closed		00341	

IP7011640

Existing Hard-Wired Control Signal List - One (1) ID Fan Variable Frequency Drive						
Device	**Type**	**Switch**	**Description**	**Power Source**	**Point Name**	**Signal**
VSD	DO		ID Fan Variable Speed Drive 1A1 Trngr Sp Command		00343	
VSD	DO		ID Fan Variable Speed Drive 1A1 Breaker Closed		00346	
VSD	DO		ID Fan Variable Speed Drive 1A1 Run Command		00347	
VSD	DO		ID Fan Variable Speed Drive 1A1 Off Command		00342	
VSD	DI		ID Fan Variable Speed Drive 1A1 Regenerative Braking			
VSD	AI		ID Fan Variable Speed Drive 1A1 Speed Control Signal			
VSD	DO		Miscellaneous Alarms 1A1			
VSD	DI		ID Fan Variable Speed Drive 1A2 Regenerative Braking			
VSD	AI		ID Fan Variable Speed Drive 1A2 Speed Control Signal			
VSD	DO		Miscellaneous Alarms 1A2			

IP7011641

ATTACHMENT 1

SUMMARY BILL OF MATERIAL

ALSTOM
Power Conversion

Summary Bill of Material

Eight (8) 7415 Hp 12/12 Pulse Dual Channel Synchronous Motor Drive Systems Including:

Eight (8) twelve/twelve pulse load commutated synchronous motor power converters (SYNCDRIVE)

Six phase Hp	7415
Rpm	954
Three phase Hp	4596
Rpm	809
Voltage	4031
N-1 Thyristors	Yes
Regeneration	Yes, 100%
Water Cooled	
Redundant Pumps @ 10000 Hp	Yes
Air-to-Water Heat Exchanger	
Redundant Fans @ 10000 Hp	Yes
Single Channel Operation	Yes
Future Capability 10000 Hp	Yes

Sixteen (16) Channel Isolation Load Break Switches

Voltage Rating	5kV
Current Rating	1200A

One (1) Training School – five days in duration to be conducted at your Delta, Utah Plant

Fifteen (15) days of field service time for installation supervision and commissioning of each drive

One (1) harmonic analysis

One (1) torsional analysis of the drive system

One (1) lot recommended power converter spare parts (See Section 2.2)

The motors, couplings, DC reactors and transformers are existing.

ALSTOM
Power Conversion

Terms of Payment

Our pricing is based on the following progress payment schedule:

% Total Contract Value	Milestone Payment Description
15%	Upon submittal of general arrangement drawings and schematics
25%	Upon initial power converter assembly
10%	Upon delivery of the switches and heat exchanger
45%	Upon delivery of the power converters
5%	Upon startup but no later than 60 days after delivery of last major piece of equipment

Recommended Spare Parts List
Variable Frequency Drive
Intermountain Power - Units 1 and 2

SAD00149

Description	Quantity
Fuse, 4800V	3
Excitation controller	1
Logic termination panel	1
Pump repair kit	1
Cooling system PLC	1
Conductivity cell	1
Conductivity analyzer	1
Filter, paper, 10", 20 micron	6
Signal isolator	1
Solenoid valve	1
Flow switch	1
Stator voltage feedback xfmr	1
Gating power supply	1
Sigma core board	1
Type C interface board	1
I/O assembly	1
Switch mode power supply	1
Pulse amplifier board	1
Power module sharing resistor	1
Power module snubber capacitor	1
Power module snubber resistor	1
Deionization tank	1
Thyristor	6
Distribution board	1
Gating board	1
Power Supply 12v DC	1
Surge Capacitor	2
Surge Resistor	2

ALSTOM

ALSTOM Power Conversion Inc.
ENGINEERING RATE SCHEDULE FOR 2003

Engineering services are provided at the following rates and in accordance with ALSTOM Terms and Conditions. Payment is due in full net 30 from the date of invoice. Rates are in US Dollars.

These rates apply to work conducted in ALSTOM Power Conversion offices or on customer sites in the USA, Canada or Mexico. For work to be performed in other locations, per diem rates will be formally quoted at a time prior to the service being performed.

Standard Service Price.

Rate 1 – Field Management Services

Straight Time	$ 176.00 / Hour
Overtime	$ 273.00 / Hour

Rate 2 - Systems Specialists

Straight Time	$ 162.00 / Hour
Overtime	$ 243.00 / Hour

Rate 3 - Field Service and Commissioning Engineers

Straight Time	$ 132.00 / Hour
Overtime	$ 198.00 / Hour

Rate 4 – Commissioning Technicians

Straight Time	$ 104.00 / Hour
Overtime	$ 152.00 / Hour

Straight time is Daylight Shift worked from Monday through Friday no more than 8 hours. A 10% shift differential will be added to all hours worked other than the Daylight Shift.
Overtime is any time exceeding 8 hours Monday through Friday, all hours worked on weekends and customer recognized Holidays.
Emergency Service is defined as responding to site within 24 hours. A 25% premium will be added to the hourly rates listed above for Emergency Service.
Minimum charge is four hours.
Travel Time is the actual time the ALSTOM personnel begins travel to the time of arrival at the assigned destination. Travel time shall be charged at Straight time rates.
Offshore Marine Service Work is chargeable at a minimum of 12 hours for any 24 hour period at sea.

Living and Travel Expenses.

Expenses can be charged in one of two ways to suit the customer.

a. Cost plus 10%, receipts will be provided.
b. Fee Hour basis of $ 34 per Labor hour charged, to a maximum of the first 8 hours ($272) per 24 Hour period. This rate includes all accommodation, food and local transport. No receipts will be provided.

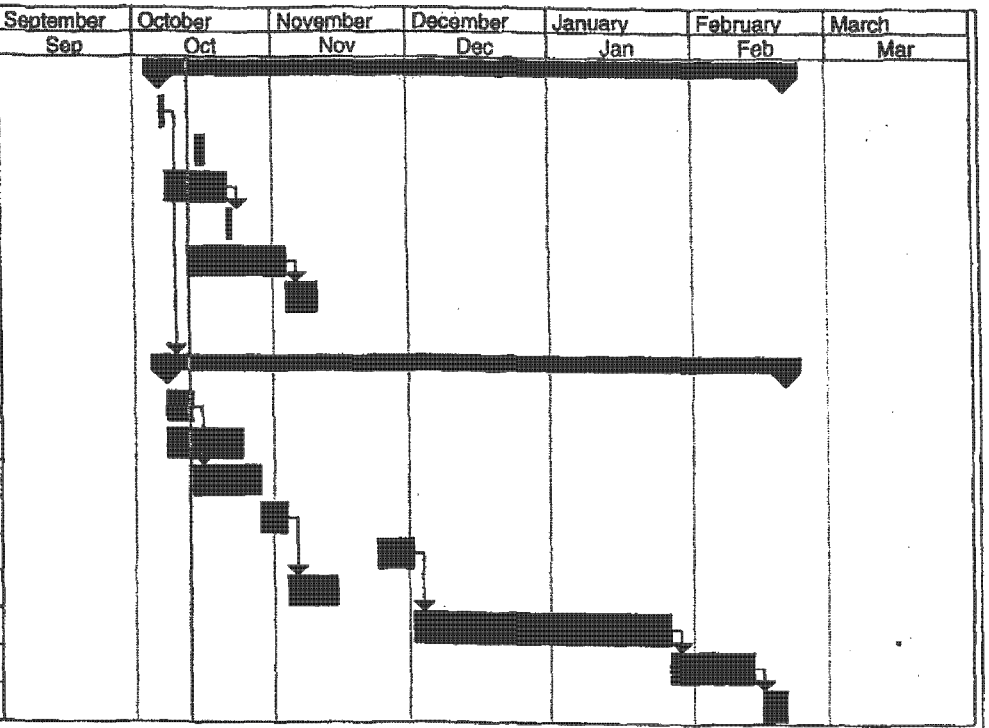
Travel expenses to and from the assigned destination are not included in this Fee Hour rate and will be invoiced charged separately at cost plus 10%, receipts will be provided.

ALSTOM Power Conversion Inc. reserves the right to change rates without notice.

ALSTOM Power Conversion
610 Epsilon Drive
Pittsburgh PA 15238

IP7011646

ID	Task Name	Duration	Start
1	**Project Overview**	**99 days?**	**Tue 10/7/03**
2	Receive Letter of Intent	1 day	Tue 10/7/03
3	Customer Kick-off meeting	2 days	Wed 10/15/03
4	Customer Finalize PO	10 days	Wed 10/8/03
5	Order Entry	1 day	Wed 10/22/03
6	Submit Approval Drawings	16 days	Mon 10/13/03
7	Drawing Approval	5 days	Tue 11/4/03
8			
9	**Drive System**	**98 days?**	**Wed 10/8/03**
10	Advanced Electrical BOM	4 days	Wed 10/8/03
11	Advanced Mechanical BOM	13 days	Wed 10/8/03
12	Issue P.O.s for Long Lead Items	11 days	Tue 10/14/03
13	Final BOM	4 days	Wed 10/29/03
14	Release for Manufacture	6 days	Mon 11/24/03
15	Balance of Procurement	9 days	Tue 11/4/03
16	Manufacture	8 wks	Tue 12/2/03
17	Test	2.8 wks	Tue 1/27/04
18	Shipment	5 days?	Mon 2/16/04



Project: GD20207 Schedule 101303
Date: Mon 10/13/03

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

INTERMOUNTAIN POWER SERVICE CORPORATION, DELTA, UTAH
UNIT 1 - ID FANS ADJUSTABLE SPEED DRIVE

IP7011647

ATTACHMENT 2

COMMENTS TO THE SPECIFICATION 45605,

TECHNICAL SECTION F2-F9

Comments to the Specification 45605, Technical Section F2-F9

DIVISION F2 – General Description and Scope of Work

7. Work or Materials Furnished by Others

In addition to the items shown we will require, for each VFD channel (2x per FAN):

- A 3 phase, 480 volt, 60 Hz, approximately 30 kVA, exciter and auxiliary power supply
- A 120 volt, 60 Hz, single phase UPS supported control power source, approximately 2 kVA
- A 120 volt, 60 Hz, single phase reference supply with direct phase relationship to the main VFD 6,900 volt power source

15. Schedule of Activities

Please refer to the schedule provided in our proposal document. See Section 2.3

DIVISION F3 – General Equipment

18 Design Coordination

The ALSTOM offer includes power converters, heat exchangers and output isolation switches.

22 Wiring

All control panel and cabinet wiring to be type SIS, 600 V insulation

DIVISION F4 – Specifications Engineering Data

7.a Drawing Submittal

Drawing and lettering practices shall be in accordance with ALSTOM Power Conversion Inc's Engineering Work Instruction (EW40502) "CAD Standards". See Section 4.6

8 Wiring Diagrams

Connection and interconnection wiring diagrams, separate from connection and interconnection data contained in the standard supplied drive system elementary drawings, are not furnished.

DIVISION F5 – General Quality System Requirements

The power converters will be built at the ALSTOM Power Conversion facility located in Pittsburgh, PA which is a registered ISO 9001 company. An overview of our Q/A Procedures is provided in Section 4.6

DIVISION F7 – Medium Voltage Variable Frequency Drives

1. General

Underwriters' Laboratories do not have published standards that apply to medium voltage equipment.

2. Performance

The VFD equipment offered is of the "LCI" type and is similar in design to the existing equipment but with more modern controls and superior performance features. However, the VFD offered is not capable of operating any standard ac motor and will not operate (provide speed control of the fan) without a motor connected. Commissioning and troubleshooting of the drive can be accomplished without a motor connected.

Input Harmonics will be assessed in accordance with IEEE 519 – 1992. Please see the enclosed Harmonic Review document for discussion regarding power factor correction and harmonic mitigation in our bid documents. Power quality metering of the type described is not part of our standard offering.

The VFD system efficiency is detailed in our bid documents but at 100% speed and 100% load exceeds 99%. This is 3% better than the specified value and should be considered in the evaluation. For 8 fan units and at $1,275 per kW this represents approximately $1,591,200.00 of savings.

A power factor correction system has not been included at this time. In order to address this a plant wide study should be considered in order to address total rather than just the drive power factor. Some improvements to the existing drive power factor can be realized with the new drive system by employing performance benefits of the more modern LCI controls.

3. Design Calculations

A preliminary harmonic analysis has been included but it is based on the actual supply system short circuit capacity rather than the proposed arbitrary value.

4. Availability

The VFD offered could be safely operated with a single ground fault present in the system but it should be noted that this kind of operation may result in damage to the motor and so is not recommended.

5. Serviceability/Maintainability

The mean time to repair of 15 minutes for power switching component failures can be achieved by replacing a thyristor module that contains a string of 10 thyristors. In order to achieve this goal it is recommended that two or more spare modules be purchased.

6. Physical Requirements

The VFD offered uses direct water-cooling and employs a single water loop containing ethylene glycol. The heat exchanger supplied must be mounted outdoors and since it is not known where these components may be located we have not included the pipe work or mounting hardware

necessary to connect this item to the drive. Our standard offer includes some CPVC piping within the drive enclosure but connections to the outdoor heat exchanger can be made from copper or stainless steel piping.

A single heat exchanger is supplied for each fan drive system that employs a redundant cooling fan feature. The heat exchanger is rated for the ultimate power capability of 10,000 Hp plus a fouling factor is included in order to ensure a long life for the heat exchanger. A temperature regulation valve is also included in the design to bypass the heat exchanger in the event of low power operation and cold conditions. This feature will reduce the risk of thermal shock or condensation problems.

The VFD offered has a NEMA 1, naturally ventilated enclosure. As forced air cooling of the enclosure is not employed dust build up inside of the cabinets should not be a problem.

A mechanical door interlock system can be supplied but is not recommended due to the large number of interlocks that would be required and so has not been included with our offer.

7. Protective Devices/Diagnostics

Surge arresters required to protect the input transformer can not be installed in the VFD. These must be installed upstream of the existing transformer that will be reused with our equipment. The VFD is supplied with surge protection inside the drive.

Fault history data can be accessed via an RS232 data link. A fiber-optic based data link is not a standard option and has not been included but could be achieved using commercially available converters if required.

8. Programming and Communications

Drive parameters are stored in a battery supported RAM not EEPROM

An Ethernet communications link is not available

9. Component Requirements

The existing DC Link Inductors will be reused and do not need to be relocated into the drive line-up. It is our intention to reuse the existing cable connections where possible.

An input or output harmonic filter is not included with our offer.

10. Output Contactor or Switchgear

A load break disconnect switch will be supplied as a free standing component for mounting next to the drive line up in place of the existing Ampgard contactor. The switch will be motor driven so that transfer to a single channel will be possible in the event of a channel failure with the minimum of fan operation disruption.

11. Testing

Each VFD supplied will be fully tested at our factory. Testing will include a separate full voltage test and a full current test for each thyristor power section. Please note that it will not be possible to establish overall system efficiency, power factor or harmonic distortion levels during these tests.

14. Startup

For the purpose of harmonic verification to IEEE 519, 1992 it is understood that "rated power" and "rated speed" are 7415 Hp and 954 rpm respectively. All testing will be conducted in the normal, dual channel mode of operation.

DIVISION F8 – Variable Frequency Drive Isolation Transformers

Not applicable as the existing transformers will be reused.

DIVISION F9 – Medium Voltage Induction Motors

Not applicable as the existing motors will be reused.

ATTACHMENT 3

SYSTEM OVERVIEW

SYSTEM OVERVIEW

The system configuration that ALSTOM Power Conversion has quoted is the same as numerous drive systems which ALSTOM has in service on utility fan applications. For maximum plant reliability, the system offered is a 12 pulse dual channel configuration with Load Commutated Inverters (LCI) and high efficiency synchronous motors.

The major system components include:

Two input isolation breakers (existing)

2 two winding input transformers (existing)

Two independent six pulse converter/inverter channels with their own regulator in a master/slave arrangement during 12 pulse operation (new)

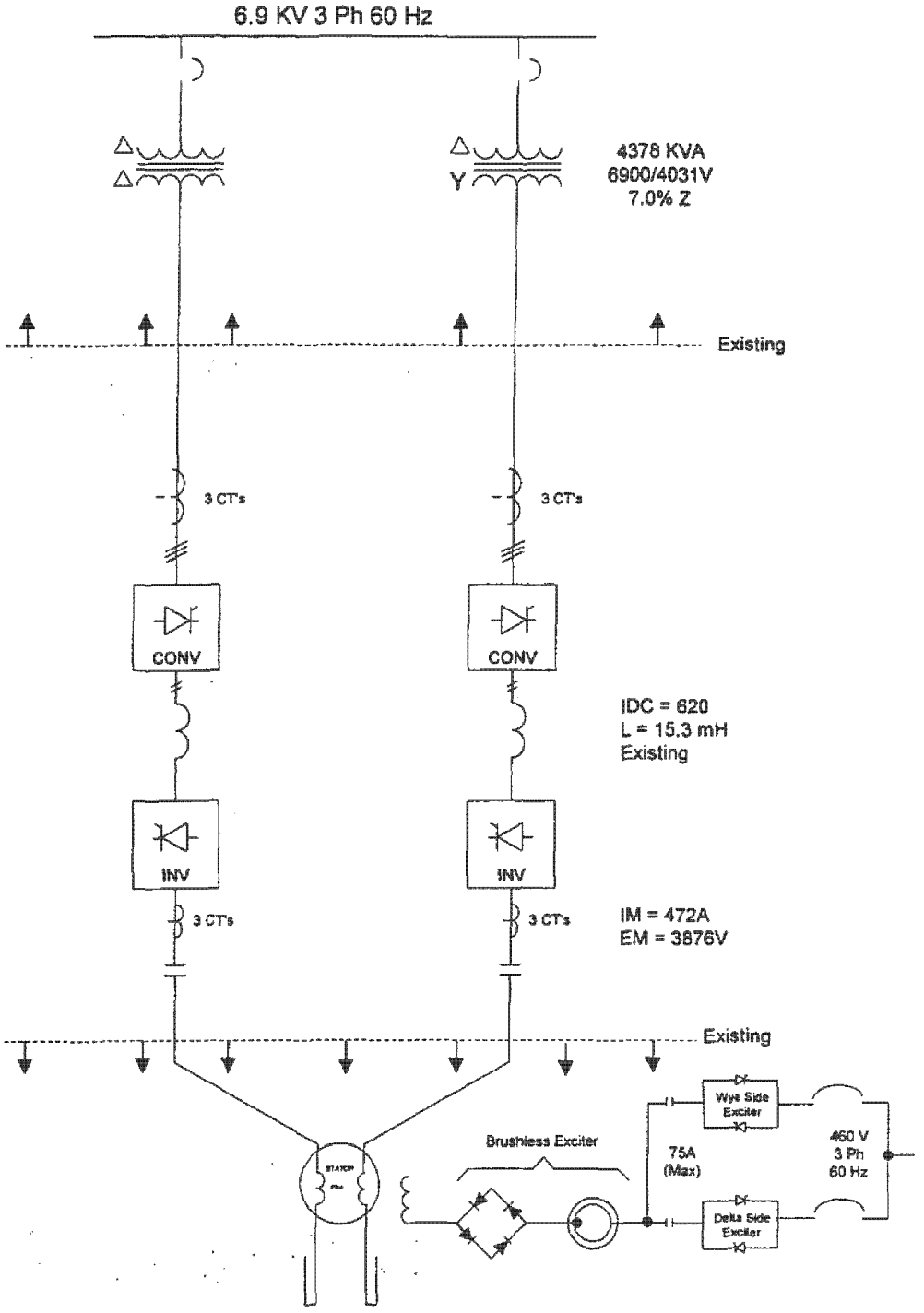
Two separately mounted outdoor dc link reactors (existing)

An output motor driven load break switch on each channel for isolation (new)

A high efficiency 6 phase synchronous motor for dual channel operation or 3 phase single channel operation (existing)

A system configuration follows:

INTERMOUNTAIN POWER
Units 1 and 2
Delta, Utah



12 Pulse Syncdrive System

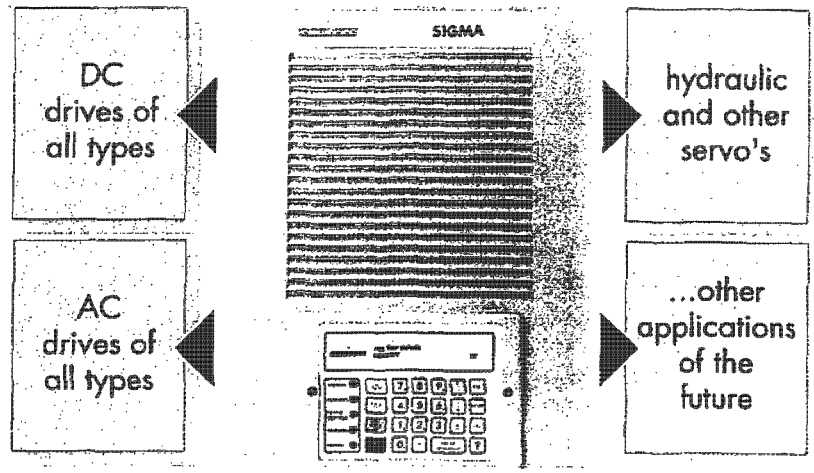
	6 Ph	3 Ph
Hp	7415	4596
Rpm	954	809

SYNCDRIVE Single Line Diagram

IP7011655

SIGMA

A single controller for all drive and servo applications



SIGMA is flexible!

With a single control-board, your process applications can now span a wider range than ever before, including for example:

- DC drives of all ratings,
- AC current-source invertors for load-commutated synchronous and induction motors,
- AC voltage-source invertors for a wide range of applications,
- AC cyclo-convertor synchronous and induction motors drives up to the largest sizes,
- high-speed controller interfaces to hydraulic-servo and other non-rotating control systems,
- many special applications and retro-fit schemes (eg Ward-Leonard refits, Kramer-system controllers).

SIGMA is fast!

SIGMA combines the speed of response of a fast analogue controller with the reliability, communications capability and drift-free stability of modern digital drives.
This gives the controller the processing speed necessary to handle the complex task of mathematically-modelled torque-control for three-phase cyclo-convertors, yet achieve the economy needed to produce competitive solutions for simple drives.

And there's processing power to spare, to handle all the status-reporting and self-diagnostics so important to today's industrial customers!

SIGMA uses advanced 80960 32-bit controller architecture for extra-fast performance, with programmable gate-array logic (alongside the 80960 processor) to take care of firing-sequence and other housekeeping tasks. The processor board includes modern surface-mount technology for maximum reliability.

Drive-specific software modules

SIGMA achieves its versatility through a range of pre-written function-related software modules. Modules for specific applications are easily down-loaded into the controller via Cegelec's range of programming tools (see table overleaf).

This means single hardware spares for an enormous range of drives - plus all the benefits of a common approach to plant-status-monitoring and diagnostics, via Cegelec's family of powerful process-support tools (see table).

SIGMA has key benefits

SIGMA includes some especially important high-tech features:

- **Power**: programmable gate-array logic, frees the processor from routine tasks, releases its power!
- **Future-proofing**: downloadable software allows easy addition of future control functions!
- **Resolution**: 180 nsec timing allows closer approach to perfect output waveform whenever needed!
- **Harmonic reduction**: reduced supply harmonics, motor heating and torque pulsations!

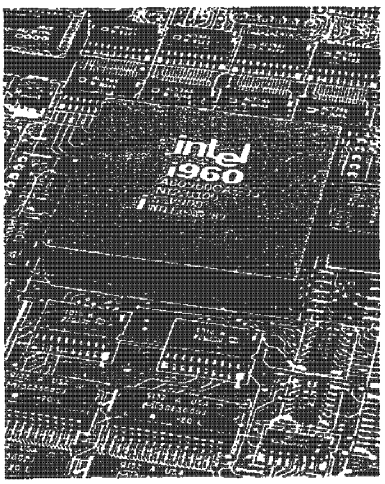
ALSTOM

IP7011656

Physical description

The SIGMA controller includes a core processor board, plus comprehensive interfaces for external signals for control and feedback (see table for full list). Plant interfaces to the different types of drives controlled by SIGMA are via a small range of custom i/o panels and firing-circuit driver boards.

For small and medium-sized drives, the SIGMA controller panel may be mounted in front of the power electronics assembly. For large drives with several cubicles of power components the SIGMA controller will normally be mounted as a separate assembly.



Surface-mount technology, 80960 32-bit processor, and programmable gate array logic, all help to make SIGMA fast and reliable.

Key features	SIGMA controller
Functionality:	▼ Flexible and accurate control of a wide range of power drives and servo's ▼ Provides firing pulses to all types of system drives, both AC and DC. • DC drives of all ratings • AC current-source inverters of all ratings • AC voltage-source inverters of all ratings • AC cyclo-converter synchronous and induction motor drives • Provides basis of high-performance servo-controller eg. FIFAC Type II etc • Use as the basis of a variety of retro-fit exercises eg. on to existing power stacks
Controller physical constituents:	▼ Power supply ▼ SIGMA core-board in plastic moulding ▼ Customer i/o panel (including software dongle protection) ▼ Link to outgoing power stack or servo, via range of application-specific interface boards
Interfaces:	▼ 2 low-speed serial ports (9.6kb/sec, ESP protocol), allowing: • local programming/configuring via PC computer, and • connection of optional keypad for parameter-adjustment, local monitoring of digital data, local control of drive, etc ▼ 2 medium-speed serial ports (76.8kb/sec, RS485, ESP & MODBUS protocols), allowing: • use of Cegelec networked tools for programming (eg OVERVIEW), and diagnosis (eg OVERDRIVE) • control link to higher-level networked system (eg plc controller) ▼ Analogue i/o: • 4 analogue inputs (eg for speed reference, input from remote plc, computer, SCADA package etc) • 4 analogue outputs (eg to separate meters, plc or computer system, data-logger, SCADA package) 4 differential opto-isolated pulse-counter inputs, programmable to give control of single and multiple-motor drives: • 1 "bi-phase + marker" input, plus 1 "unidirectional + marker" input • 2 bi-directional pulse-counter inputs ▼ Digital i/o: • 16 opto-isolated digital inputs • 8 opto-isolated digital outputs
Enhancement cards:	▼ 4 vacant slots are provided in the controller, for a range of plug-in cards including: • Resolver input • HDLC adapter (to give high-speed 150kb/sec serial link capability) • FIP (Fieldbus) adapter
Configurations:	▼ SIGMA acts as the heart of a wide range of AC & DC drives and servo-controllers ▼ Controller is fully software-configured (no E-PROMS or similar changes needed!) ▼ Specific configuration for each application makes full use of "libraries" of dongle-protected pre-written application-ware, for cost-effective and standardised system-building
Programming and monitoring:	▼ Programmable via two alternative packages: • Stand-alone PC running Cegelec's DOS-based "SIGMA Programmer" software • Stand-alone or networked PC running Cegelec's OS/2-based "OVERVIEW" software ▼ Fully compatible with Cegelec "OVERDRIVE" monitoring/diagnostic software ▼ Optional keypad allows adjustment of drive parameters (password-protected access), and monitoring of selected digital output signals
Advanced performance:	▼ SIGMA includes an advanced processor, to achieve analogue-system response from a digital drive, whilst supporting high data-flow rates for diagnostics & monitoring: • 32-bit RISC processor for ultra-high speed response • Intel 80960CA 16MHz processor (33MHz for high-performance applications, eg cycloconvertors) • Built-in battery-maintained real-time clock • Timing resolution down to 160×10^{-9} sec (with 33MHz processor)

Area office

ALSTOM

IP7011657

ALSTOM
Power Conversion

SYNCDRIVE
TECHNICAL DESCRIPTION
LOAD COMMUTATED SYNCHRONOUS DRIVE SYSTEM

A. GENERAL

The equipment incorporates a brushless synchronous motor which is speed controlled from naturally line commutated, electronically protected thyristor converter equipment. The thyristor equipment is designed for front access only. The power cubicles house the supply converter bridge and the machine converter bridge.

The input to the supply converter is fed from the incoming supply via an isolation transformer. The supply converter is connected to the machine converter through a dc air cored reactor. The ac output terminals of the machine converter are connected directly to each three phase stator winding of the synchronous motor.

Description of Operation

When the motor speed reference is increased, the supply converter firing pulses are adjusted to increase the dc link voltage between the supply (or input) converter and the motor (or output) converter. In turn, this causes the current flowing into the stator windings of the synchronous motor to increase and hence, the motor to rotate faster.

The generated voltage measured across the motor terminals increases in magnitude and frequency. The generated voltage rises to equal the increase in dc link voltage, and the current in the stator windings decreases while the synchronous motor settles to the required speed.

The motor operates entirely in synchronism with the power controlled by the drive. Measurement of the output frequency gives an accurate measurement of the actual motor speed. The speed regulator compares motor speed with the speed reference signal. A large speed deviation causes more current to be forced through the relevant motor stator winding in order for the motor speed to follow the speed reference. The closed-loop speed control system and synchronous operation offers speed regulation (no load to full load) of better than 0.1% and speed control accuracy of better than .5% of rated speed.

B. ENVIRONMENTAL/PERFORMANCE DATA

Location: Indoors

Altitude: Up to 6000 feet

Ambient Temp:	Operating: 0 C to 50 C.
Storage:	-10 C to 75 C (water removed)
Humidity:	Maximum 95% RH at 30 C dry bulb
Enclosure:	NEMA 1
Finish:	ANSI #61 gray paint
Converter pulse #:	12 pulse supply and 12 pulse machine converter
Cable entry:	Bottom
Speed regulation: (NL-FL)	0.1% of rated speed
Speed accuracy:	0.5% of rated speed
Cooling:	Deionized water

C. Control Supplies

The following supplies are required:

1) A 120V, 1 phase, 60 Hz., 25VA phase reference supply. This supply will come from a potential transformer in the supply breaker.

2) A 480V, 3 phase, 60 Hz., auxiliary and exciter supply. This supply will be from the control house MCC.

Supply Control

The ac supply is fed to the thyristor equipment through an AC breaker, the purpose of which is to provide a power disconnect. In the event of a fault, the variable speed drive will initiate a fast shutdown via an electronic circuit to trip the breaker in order to disconnect the circuit from the supply.

D. EQUIPMENT OUTPUT RATING

Output Frequency

The drive has the capability of operating the motor at frequencies from 0 to 90 Hz. To meet the requirements of the existing system, the drive will operate the motor continuously from 6Hz to 63.6 Hz (90 – 954 Rpm).

E. DRIVE CONTROL

An auto/manual switch is provided to enable either remote start and speed reference circuits or local start and speed reference circuits to operate.

A speed reference signal is provided locally via a keypad for use in the manual switch position. In the auto position, the equipment accepts a 4-20 mA signal from the compressor unit control panel. Gain and offset adjustments are also provided.

Separate minimum speed adjustments are provided for auto and manual. A maximum speed adjustment is provided, effective on both auto and manual.

An adjustable linear acceleration function is provided, which is programmed to meet the project requirements.

The machine exciter is controlled via an ac power controller located in the regulator cubicle.

1. Control Facilities

The drive control is provided by a fully microprocessor based controller suitably programmed for the synchronous motor drive.

This system allows for serial communications to the unit control panel programmable controller.

Local communication into the system will be provided by a keypad with a liquid crystal display and this is provided with coded and password access to prevent unauthorized use.

2. Fault Detection Facilities

Alarm faults are arranged to bring up an alarm indication only so that the drive can be allowed to continue operating under operator supervision. Trip faults bring up an alarm and initiate a drive trip sequence via the microprocessor by applying fast phase back and pulse suppression followed by a circuit breaker trip.

All fault conditions are continuously interrogated and in the event of a fault the first fault condition is automatically displayed in English language messages on the LCD display. Follow up faults are readily available and the condition of all other fault detectors are inspected at will on command from the keypad.

The following fault detection is provided:

a. Fault Condition	Alarm	Trip
Machine Overcurrent - Instantaneous		*
Supply Overcurrent - Instantaneous		*
Supply Overcurrent - Inverse Time	*	*
Supply & Machine Current Parity		*
Excessive Supply Voltage Dip (with UPS only)	*	
Cooling System Overtemperature	*	*
Thyristor Overtemperature		*
Speed Reference Failure	*	
Microprocessor Fault (Watchdog)		*
Encoder Fault		*
Motor Overspeed		*
Stator Overvoltage		*
Excitation Fault		*
Stator Overcurrent		*
Supply Circuit Breaker Tripped		*
Supply Transformer Fault		*
Fault in Supply Switchgear		*
Stall Detected	*	
Plug Interlock		*
Thyristor failure (alarm optional)	*	*
Door Interlock		*
Gating Power Supply Fault	*	*
Surge Circuit Fuse Blown	*	

The above provides a representative list. Additional items may be available by the SIGMA regulator or a separate logic panel (PC Option).

3. Diagnostics

The system is designed to make fault diagnostics easy and understandable.

Fault conditions are displayed in words on the LCD display. Faults associated with an individual thyristor state the location of the device.

a. First Fault

The diagnostic facilities on the drive incorporate a memory feature which display the first fault so that the true reason for the trip is known.

b. Fault History Recording

Operating parameters are selected by the user and programmed into the microregulator for fault indications. The events leading up to a fault and the events subsequent to the first fault are stored and are easily retrievable. The fault history is downloadable to a portable or remote computer for graphical display.

c. Load/Save Drive Set-Up Variables (RS232 Interface)

The particular setup of a drive, e.g. maximum and minimum speeds, acceleration rates, current limit etc. is available to be downloaded via the RS232 interface to a portable computer. The set up conditions are also available to be put into the system via the same interface to reduce commissioning/setting up time.

F. PROTECTION

a. Thyristor Protection

The following protection facilities are provided:

1) Electronic protection against overcurrent. The thyristor pulses are phased back rapidly or inhibited if an overcurrent in excess of the current limit value is detected. This protection is coordinated with tripping of the supply disconnect.

2) Voltage sharing components are included across individual thyristors to insure that impressed arm voltages are evenly distributed between the series connected thyristors. These components comprise the parallel connection of a resistor and a resistor/capacitor "snubber circuit".

G. INDICATION AND MONITORING

Form C contacts are provided for customer use indicating:

Drive ready
Drive running
Drive failure

Separate LEDs are provided for indication of thyristor healthy, gate pulse healthy, and gating power supply healthy. Associated alarms or trips are shown on the LCD display.

H. CONSTRUCTION FEATURES

Component layout is designed for ease of maintenance and inspection. All functional components can be readily removed without need to disturb other components and wiring.

Cable segregation is utilized to minimize electrical interference between power and control circuits.

Both ends of each control wire are identified using numbered slip-on wire ferrules.

The more complex functional units within the equipment are designed as removable modules for ease of maintenance and fault finding.

I. COOLING SYSTEM

Introduction

The cooling system removes heat from the principal heat generating components, transfers that heat to an external medium, monitors its own performance, and provides alarms for abnormal operating conditions.

The cooling system consists of the following principal components:

1. Pump cubicle;
2. Cooling system controls and controller (CSC);
3. Heat exchanger – water-to-water or water-to-air;
4. Redundant coolant pumps
5. De-ionizer tank;
6. Make-up water tank (Reservoir);
7. Strainer and filter;
8. Instrumentation;
9. Heat sinks (Chill Blocks);
10. Water-cooled resistors;
11. Piping and hosing;

I. Design Discussion

Large, water-cooled drives use series strings of hockey puck type thyristors sandwiched between water-cooled heat sinks for both converters and inverters. The heat generated by the

thyristors is removed by de-ionized water, or a de-ionized water and glycol mixture (antifreeze, flowing through the heat sinks, also called chill blocks, which are mounted on both contact surfaces of the thyristors. Certain of these chill blocks also function as AC and DC electrical connection to the series string.

Each series string of thyristors, together with its associated components forms a module. The thyristors in a module form two opposite bridge arms sharing a common alternating current connection in the middle of the string with the plus and minus DC connections at the ends of the string.

The design provides for up to six separate water-cooled modules in a cubicle. Each set of three modules forms a complete three-phase (six pulse) thyristor bridge having the required number of series connected thyristors in an arm. Each arm may have two to five thyristors. The modules may therefore have four to ten thyristors and five to eleven heat sinks.

Each module is horizontally mounted in the cubicle with the modules arranged one above another.

Connected in parallel with every thyristor is a snubber circuit consisting of a series connected resistor and capacitor. Because the snubber resistors can dissipate significant power, these are also water-cooled. These resistors use a non-inductive winding wound over but insulated from, a copper tube core. These same type of resistors also are used in the input and output surge suppressors.

The individual thyristor heat sinks are manufactured of copper. A "U" shaped water path is drilled through the heat sinks. The sharp corners of the "U" produce turbulence to ensure maximum heat transfer between the heat sink and the water. Individual heat sinks are interconnected with flexible hose. These small diameter water hoses are also used to connect each module to large diameter, vertically mounted inlet and outlet header pipes. These inlet and outlet water hoses may be equipped with self-sealing quick disconnects to permit module removal with minimum loss of water.

In order to minimize the differential water pressure across a module, a parallel connected water feed system may be used for cooling the heat sinks on dives above 4000 HP. Keeping the pressure as low as practical reduces the size of the pumps needed and helps reduce leaks by reducing the stress on hose connections and joints. The approach also insures that all heat sinks will operate at approximately the same temperature.

The de-ionized water used in the system is a high resistivity, or low conductivity, coolant. A low conductivity coolant is essential to provide phase to phase isolation, electrical insulation between individual chill blocks, between snubber resistors, between surge resistors, and between chill blocks or resistors and ground. All the same diameter hoses to chill blocks or resistors have a high linear resistance and are arranged to be long enough so as to provide

adequate electrical resistance between water circuits at different potentials in conjunction with the use of the de-ionized water.

The vertically mounted, large diameter header pipes for each thyristor cubicle are connected to appropriately sized horizontal pipes arranged near the floor and the ceiling of the cubicles. As far as is practically possible, the piping layout, selected pipe sizes, and if necessary, control valves, ensure an equal distribution of water to each module and to each individual heat sink.

Redundant coolant circulation pumps are provided. Only one pump operates at any given time, and the performance of the operating pump is continuously monitored. Failure of the operating pump results in automatic changeover to the standby pump with uninterrupted drive operation. A failed pump may subsequently be replaced while the drive is in operation. Depending upon the requirements of the user, selection of primary and standby pumps may be manual, or may be accomplished by the cooling system controller via an algorithm which seeks to equalize total running time of each pump.

II. Operation

A. Pump Changeover Sequence

The pump control logic calls for a pump to run at all times, provided that the auxiliary pump power supply is energized, regardless of whether the drive is operating. This ensures a continual flow of coolant through de-ionization loop in order to keep the coolant conductivity level sufficiently low. A drive start is permitted provided that the cooling system permissive is present, i.e., no cooling system faults exist. A pump changeover when the drive is operating is initiated by reduction of water flow, as signaled by a flow switch. When the flow rate has fallen below the set value, the running pump is de-energized and the standby pump is energized. Provided the water flow reaches the set value within 3 seconds of calling for the standby pump to start, the drive continues to run. However, if the second pump fails to start up within this time, then the complete drive is stopped.

For systems with automatic equalization of pump running time, changeover to the pum with the lessor operating time occurs immediately following a drive stop.

B. Alarms and Trips

Instrumentation is included to monitor the cooling system and initiate alarms and corrective action, i.e. changeover to standby pump, and to also trip the drive if necessary.

The following alarms are provided:

1. Loss of flow (pump failure);
2. Obstruction in water piping (low flow);
3. Loss of pump motor (or heat exchanger fan motor) contactor;
4. Loss of 120 VAC auxiliary supply;
5. Coolant over-temperature alarm;
6. Coolant over-temperature trip;
7. High conductivity alarm;
8. High conductivity trip;
9. Leakage of water from system;
10. Low reservoir level alarm;
11. Low reservoir level trip (optional);

III. System Design Standard

The cooling system is designed to operate at high flow and low pressure. The system operates on the flat part of the pump performance curve. The low-pressure design reduces the probability of coolant leaks. The complete system is pressure tested. The test pressure for the complete system is 60 PSIG or higher. The leakage is applied for 8 to 12 hours. There should be no sign of leaks during this time and the pressure must not decrease by more than 5 PSIG.
The test pressure for any external process water (secondary water) loop should be 150 PSIG.

IV. Component Descriptions

A. Pump Cubicle

The pump cubicle contains many of the main cooling system components including the de-ionizer tank, conductivity analyzer, monitoring instrumentation, and pumps.

All the principal components in the pump cubicle have isolation valves to assist in maintenance and replacement, if required.

A "Y" strainer is included to filter out any suspended solids during test and commissioning stages.

The de-ionizer system is designed to accept a small fraction of the main primary water flow to continuously maintain the low conductivity of the coolant. Only a fraction of the main flow is needed to circulate through the de-ionizer. The de-ionizer flow adjusted by a suitable flow control valve and monitored by a variable area flow gauge.

A drip tray may be included in the pump cubicle, or the bottom of the cubicle used as one, to detect leakage in that part of the cooling system most likely to leak, the pump seals. A moisture or water level detector is used to give an alarm when water accumulates.

B. Cooling System Controller

In most cases a dedicated programmable logic controller, located in the pump cubicle, performs the pump selection and monitoring functions associated with the cooling system. In some instances, the drive's Sigma regulator may be provided with expanded input/output capability and may be employed to execute the requisite control and monitoring functions.

In the case of a separate dedicated controller, the controller monitors each of the discrete devices described above (flow and temperature switches, pump starter auxiliary contacts, conductivity monitor contacts, etc.) along with a "drive running" signal from the drive regulator. In addition to providing the pump start commands, the controller provides "cooling system alarm" and "cooling system fault" status contacts to the Sigma regulator, and controls a cooling system diagnostic panel located on the door of the pump cubicle. Where a Sigma regulator with expanded I/O capability is used in lieu of a dedicated controller, the Sigma performs all of these functions, except that diagnostic messages are displayed directly on the Sigma keypad rather than via a separate panel.

C. Water-to-water heat exchangers

Water-to –water heat exchangers are used when water or other suitable coolant is available in the plant in which the system is installed. The de-ionized water loop is then the primary loop and the plant water the secondary coolant loop.

The heat exchanger may be either tube and shell or plate type construction. These heat exchangers permit 100% counter flow of both primary and secondary water. The advantage of this arrangement is that the difference in temperature between the two water circuits participating in the heat exchange is fully utilized.

The secondary coolant may be any suitable liquid such as filtered raw water, chilled process water, or chilled ethylene or propylene glycol solutions.

D. Water-to-air heat exchangers

When plant or process water is not available for cooling, a force-cooled water-to-air heat exchanger is used. This unit is usually installed outdoors to dump heat into exterior air. This reduces plant air-conditioning requirements and lowers the interior noise level.

E. Pumps

The motor operated pumps are centrifugal, close-coupled units drive by three-phase, totally enclosed motors. The pumps include Crane mechanical seals and are selected for use with de-ionized water.

The system has a working pressure of 20-35 PSIG. Test pressures are typically two times the working pressure or a minimum of 60 PSIG.

F. De-ionizer

The de-ionizer (DI)tank consists of a mixed bed polisher with both cation anion exchange resins contained in a reusable, non-metallic housing. When the ion exchanger resins are exhausted, the entire tank can be returned to the manufacturer for regeneration. Alternatively, local on-site exchange service is typically available. Various sized tanks are used depending on the coolant capacity of the system.

The percentage of flow fed to the de-ionizer is approximately 1 to 5% of the total flow. A 20-micron paper filter is typically used ahead of the de-ionizer to catch particles that might clog the polishing tank.

The de-ionizer tanks should generally be replaced at six-month or longer intervals, i.e. no more than twice a year. Tanks should not normally require replacement at shorter intervals than this. Longer intervals may be used if the conductivity of the water remains low at a particular installation. If, with maximum flow through DI tank, the conductivity of the coolant cannot be maintained at less than 2 S/cm, the DI tank must be replaced. Filters should be changed whenever the DI tank is changed.

Isolation valves are provided, in the form of self-sealing quick disconnects, so that the DI tank may be replaced while the drive is running.

G. Conductivity Analyzer

The cooling system has a monitoring system that constantly analyzes and displays the quality of treated water produced by the tank.

The monitoring system consists of a conductivity cell plus analyzer. The analyzer has two alarms that can be set to activate at any conductivity level between 0 and 99.9 S/cm, depending upon the quality of water required. Once water quality falls below a predetermined level (conductivity increases above set level), the alarm is automatically raised indicating that the tanks need changing. Further loss of water quality will shut the system down.

The normal working range is 0.3 to 1.5 S/cm. The first alarm is typically set at 1 S/cm. The second alarm is set to trip the system at 2 S/cm.

H. Make-up Water Tank

This tank provides pressure in the primary system helping to provide positive pressure to the suction inlet of the pumps and displace air in the system. It also provides reserve capacity if there is a leak or problem in the cooling system. The tank is a convenient place to mount level detectors to check for system leaks or water evaporation.

I, "Y" Strainer

The "Y" Strainer's principle function is to strain out any loose material, e.g. shavings or other particles, which may have entered the pipe work during manufacture or installation. The strainer is normally either bronze or polypropylene with a polypropylene, or stainless steel mesh screen. The mesh size is typically 20 with approximately 1/32" hole sizes. The mesh is cleaned during factory tests and should be cleaned again during the commissioning process.

Since the de-ionized water cooling circuit is a re-circulating system and since only clean, filtered, topping up water should be used, the strainer is not needed after commissioning. Therefore, there will be no need to clean the strainer on a regular basis.

Although the "Y" strainer is normally not needed after start-up, it is possible that is can become clogged over time. This can be detected by two means: First, the flow through the DI tank may decrease. That flow is affected by the pressure differential around the pumps. If the DI tank filter is not becoming clogged, it may be a sign that he "Y" strainer is becoming clogged.

Another indication of the "Y" strainer becoming clogged is loss of flow in the system. This may be indicated by frequent loss of flow alarms.

J. Instrumentation

1.Flow sensor (Paddle switch).
2.Low level alarm (Float switch) in make-up water tank. An optional second level detector is also available for alarm or trip purposes.
3.Temperature and pressure gauges.
4.Water over-temperature alarm (Thermal switch). An optional second temperature switch is available for alarm or trip purposes.
5.Conductivity alarm (Conductivity monitor).

6.Pump cubicle leakage alarms (Moisture switch or level detector).

V. Oxygen Entrapment/Chemical Impurities

The conductivity meter continuously monitors the conductivity of the water. Since the conductivity is a measure of the soluble chemical content of the water, there is no need to carry out any other chemical analysis test on the primary water. The de-ionizer tank should be changed when the conductivity exceeds 2 S/cm.

Since the cooling system is re-circulating system, the quantity of insoluble impurities in the system will not increase with time provided any topping of water is free from contaminants.

In systems using a water-to-water heat exchanger, the metals in contact with the secondary water are typically copper, or 316 stainless steel. As the maximum operating temperature for this water is 40°C, no adversely appreciable migration or corrosion will occur on this side.

VI. Settings

A. De-ionization Tank Flow Rate

During initial start-up of the drive the flow control on the flow indicator (FIC on the P&ID) is normally set to maximum. This permits the quickest reduction of conductivity to operating levels. Once the operating level (less than 2 S/cm) has been reached, the flow rate through the DI tank should be reduced to a level that maintains conductivity between 0.25 and 1.0 S. This will yield the maximum life for the DI tank and prevent conductivity from going so low that it affects the materials in the cooling system. (Very low conductance water – less than 0.25 S/cm – acts like a universal solvent. It tends to therefore dissolve even materials selected specifically for use with the de-ionized water.)

B. Flow Balancing

Control valves (identified as CV on the P&ID) are included to balance the flow to the converter and inverter lines and to the surge resistors. These valves are set at the factory and should not be adjusted. These valves may or may not have their adjusting handles removed. For unusual situations flow to the surge resistors may be measured using a flow meter that is available from the factory.

Flows to the modules are balanced by the design of the equipment and will not need adjustment over the life of the drive. Should it be suspected that the flow rates are not sufficient to cool the devices, the same flow meter used for surge resistors may be used.

C. Flow Alarm

The flow switch that detects low or loss of flow is set at the factory and should not be adjusted. If the operation of the switch is suspect, a rough check of its operation can be made by closing on of the main valves to reduce flow to a level which causes the switch to operate. CAUTION! Do not close any of the main valves with the drive in operation! This will cause the drive to trip!

Calibration of the flow sensor can also be done externally to the drive on any calibration system suitable for flow sensors.

VII. TROUBLESHOOTING

A. Diagnostic Panel Indication

This section describes the various alarm and fault indications provided via the cooling system diagnostic panel. The panel is an engraved phenolic plate affixed to the outside of the pump cubicle door. A printed circuit card is mounted behind the engraved plate on the inside of the door such that LED's protrude through holes in the phenolic plate and correspond to the engraved messages. For drive applications where the cooling system logic and monitoring is performed by the Sigma controller, diagnostic messages similar to those described below will appear on the keypad display unit.

The top LED is green and lights to indicate that the cooling system is healthy, i.e., no alarm or fault conditions exist. The second and third LED's are red, and are used to indicate cooling system trip or alarm conditions, respectively. A trip condition is one that results in a drive shutdown, while an alarm condition represents a warning, but does not preclude operation of the drive. The remaining LED's are red, and each corresponds to a particular failure condition. Each failure condition is briefly described below, with more comprehensive troubleshooting suggestions provided in the following paragraphs.

Pump Failure: This LED is used to indicate a loss of flow which may have been indicated by either a flow switch that is not closed or by a pump starter auxiliary contact that has not closed when anticipated. Upon the initial occurrence of either of these conditions, the pump failure and cooling system alarm LED's will light, and the controller will request the standby pump to start. Failure of the bypass pump or subsequent loss of flow will result in a drive shutdown and illumination of the cooling system trip LED.

High Temperature: This LED indicated that the coolant temperature has exceeded the alarm level if accompanied by the cooling system alarm LED, or that it has exceeded the

fault level if accompanied by the cooling system trip LED. In the latter case, a drive shutdown will also occur.

Coolant Conductivity: As with the previous indications, this may be either an alarm or trip condition depending upon whether it is accompanied by the cooling system trip or alarm LED's. A coolant conductivity alarm or trip occurs when the conductivity of the primary coolant, as measured by the conductivity monitor, has exceeded the permissible thresholds. The presence of this alarm should be taken as an indication to replace the de-ionization tank.

Low Reservoir Level: A low reservoir level alarm indicates that the water level in the coolant make-up tank has dropped to a level below the position of the tank float switch. Refer to previous instructions in this section for replenishing the coolant level.

Moisture Detected: A moisture-detected alarm indicates the presence of water in the drip pan or floor of the pump cubicle. The most likely cause of this indication is a coolant leak resulting from worn pump seals.

B. Low or Loss of flow alarm/trip

1.Pump failure
- a. Pump cavitation – Air in the system
- b. Loss of power to the pump motor – May also be accompanied by a pump starter failure alarm
- c. Loss of control power – Blown fuse
- d. Loss of pump starter contactor coil –
- e. Operation of thermal overload protection
- f. Seized pump

C. Over-temperature alarm/trip

1. Water-to-Air type heat exchanger equipped units
   - a. Clogged radiator fins
   - b. Loss of radiator fan belts
   - c. Fan motor failure
   - d. Loss of fan motor power
     - (1) Tripped circuit breaker or blown fuse
     - (2) Loss of control power or motor contactor
     - (3) Operation of thermal overload protection
     - (4) Loss of radiator fan motor

2. Water-to-Water type heat exchanger equipped units
   - a. Loss of secondary cooling water

b. Clogged secondary cooling water filter
c. Clogged heat exchanger

D. High Conductivity Alarm

1. De-ionizer tank chemicals expended
2. Clogged DI tank filter
3. Clogged DI tank
4. DI tank flow rate too low
5. Use of improper antifreeze in make-up water
6. System has not been circulating water for a long enough time

E. Low coolant alarm

1. Coolant leak
2. Drain valve left open
3. Pump seals failure – Should also be accompanied by a Pump Cubicle Moisture alarm

F. Pump Cubicle Moisture alarm

1. Pump seal failure
2. Make-up water tank overflow
3. Piping or valve leak

ALSTOM

Contents

		Page Number
1.Introduction		3
2.General Features		3
3.Loading Application Software		4
4.System Map		5
5.Display Pages		6
Page.1	General Mimic	6
Page.2	Event Log	7
Page.3	Alarm and Trip Log	8
Page.4	Variable Trend	9
Page.5	Bearing Temperatures	10
Page.6	Temperature Trend	11
Page.7	Winding Temperature	12
Page.8	PCR Temperature	13
Page.9	Set Time	14
Page.10	Set-Up Display	15
Page.11	User Login	16
Page.12	Alarm Annunciator	17
6.Alarm / Trip Messages		18

IP7011674

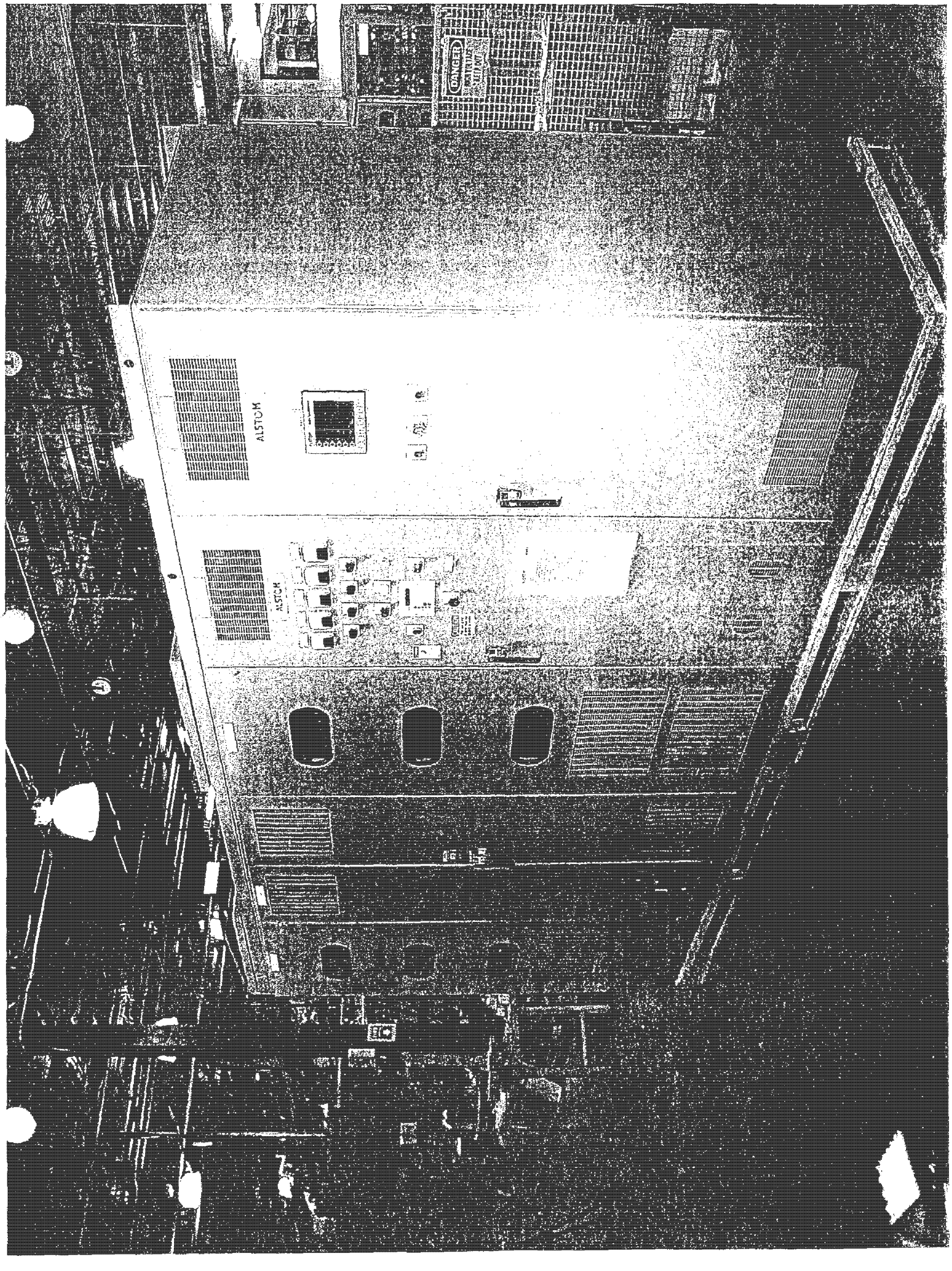
1. Introduction

This document identifies and explains the Human Machine Interface (HMI) formats and functions for the Reliant Energy Parish 8 dual Channel syncdrive systems.
The HMI is fitted to the door of each Master Control cabinet, and is interfaced to the Allen Bradley PLC via a 4 wire RS485 serial link as detailed in the project drawings PA20343\3101-004.
Data is read from the SIGMA by the PLC and is in turn read by the HMI and displayed on the relevant user pages, input data from the user is written directly to the relevant PLC data area and then used in the process control

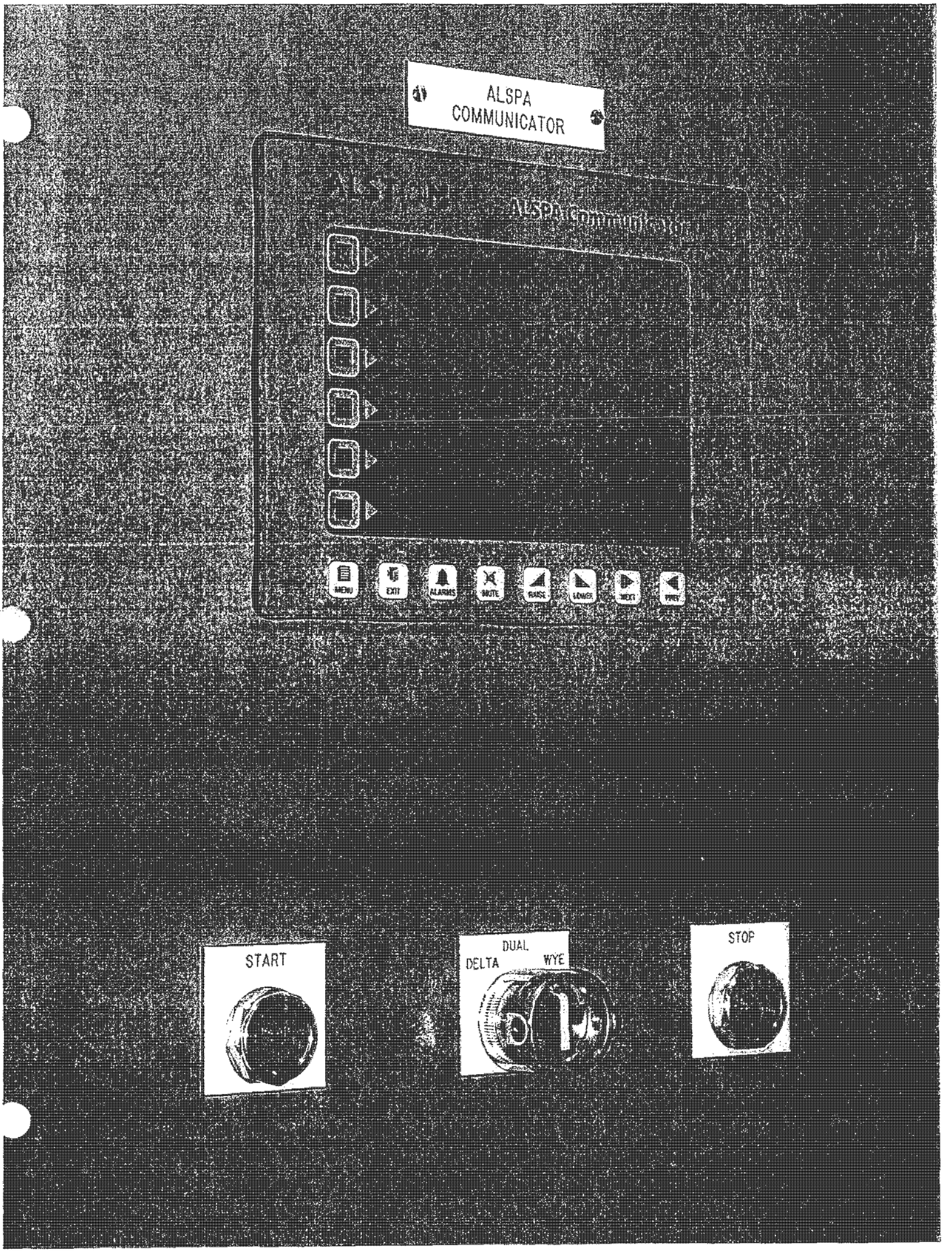
2. General Features

1. 640 x 480 PIXEL CCFL LIQUID CRYSTAL DISPLAY-7.5" DIAGONAL DSTN COLOR-FULL VGA (16 colors)
2. Touchscreen data entry and selection (VX500T only)
3. Touch menu system for easy navigation (VX500T only)
4. 500 point event and sequence log
5. 500 point alarm and trip log
6. Overall system mimic for easy status monitoring
7. 20 minute trending of key system power variables
8. 12 hour trending of temperature variables
9. Motor bearing and winding monitoring and alarm point setting
10. PCR temperature monitoring and alarm point setting
11. Alarm and Trip Annunciation
12. Viewing angle adjustment
13. Analogue meter replacement
14. Real time clock

IP7011675



IP7011676


ALSPA
COMMUNICATOR
MENU
EXIT
ALARMS
MUTE
RAISE
LOWER
NEXT
PREV
START
DUAL
DELTA
WYE
STOP

IP7011677

ALSTOM

Customer	**Reliant Energy**
Project Number	**PA20343**
Project Name	Parish 8 Dual channel Sync Drive
Document Name	HMI User Instructions
Document Number	20343HMIUI.DOC
Author	Andy Heath

IP7011678

Contents Page Number

1.Introduction 3

2.General Features 3

3.Loading Application Software 4

4.System Map 5

5.Display Pages 6

Page.1	General Mimic	6
Page.2	Event Log	7
Page.3	Alarm and Trip Log	8
Page.4	Variable Trend	9
Page.5	Bearing Temperatures	10
Page.6	Temperature Trend	11
Page.7	Winding Temperature	12
Page.8	PCR Temperature	13
Page.9	Set Time	14
Page.10	Set-Up Display	15
Page.11	User Login	16
Page.12	Alarm Annunciator	17

6.Alarm / Trip Messages 18

IP7011679

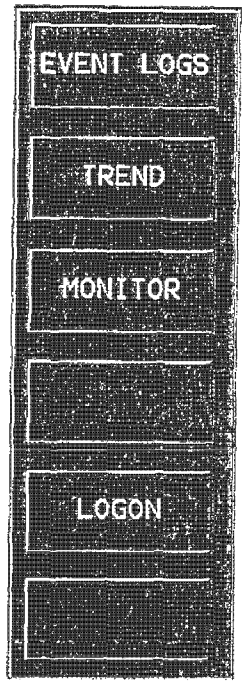
1. Introduction

This document identifies and explains the Human Machine Interface (HMI) formats and functions for the Reliant Energy Parish 8 dual Channel syncdrive systems.
The HMI is fitted to the door of each Master Control cabinet, and is interfaced to the Allen Bradley PLC via a 4 wire RS485 serial link as detailed in the project drawings PA20343\3101-004.
Data is read from the SIGMA by the PLC and is in turn read by the HMI and displayed on the relevant user pages, input data from the user is written directly to the relevant PLC data area and then used in the process control

2. General Features

1. 640 x 480 PIXEL CCFL LIQUID CRYSTAL DISPLAY-7.5" DIAGONAL DSTN COLOR-FULL VGA (16 colors)
2. Touchscreen data entry and selection (VX500T only)
3. Touch menu system for easy navigation (VX500T only)
4. 500 point event and sequence log
5. 500 point alarm and trip log
6. Overall system mimic for easy status monitoring
7. 20 minute trending of key system power variables
8. 12 hour trending of temperature variables
9. Motor bearing and winding monitoring and alarm point setting
10. PCR temperature monitoring and alarm point setting
11. Alarm and Trip Annunciation
12. Viewing angle adjustment
13. Analogue meter replacement
14. Real time clock

IP7011680



Main Soft-key Menu will slide out over main mimic page Allowing navigation to other pages.

3. Loading Application Software

1.Run the Edict97 programming tools.
2.Open file 20343_HMI_REV_001
3.Connect Edict97 programming cable from PC com port to HMI program port located at rear of unit. If HMI displays "INVALID DATABASE" then goto 13.
4.Press EXIT key on HMI to return to main page
5.Press MENU key to activate main menu
6.Choose LOGIN.
7.Select Username "Alstom"
8.Enter Password
9.Press MENU key to activate main menu
10.Choose SETUP
11.Choose LOAD
12.System will display message "TRANDFER"
13.Choose ***communications***, ***send*** from the Edict97 menu structure, Edict97 will display an activity bar and indicate when complete
14.HMI will restart with new software.

IP7011681

4. System Map

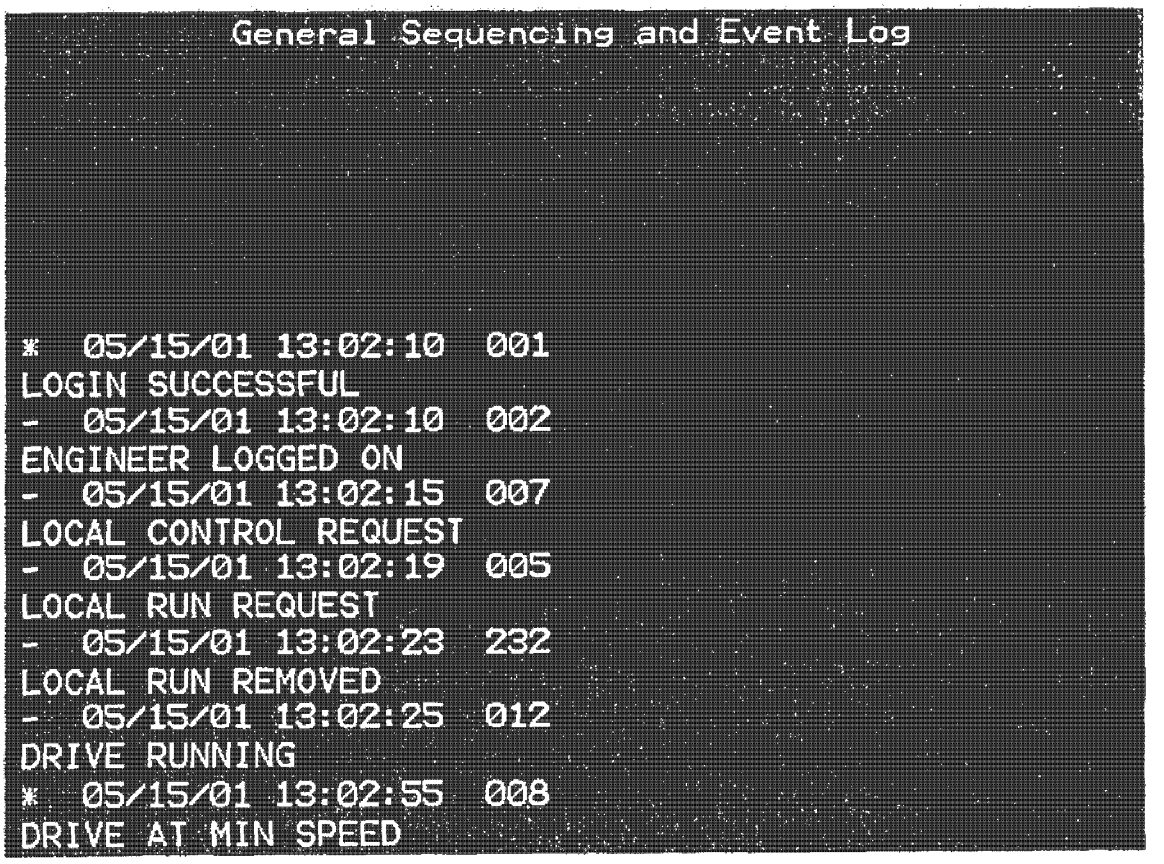
IP7011682

Page.2

Description : Event Log

Access : Any level, Exit, Menu, Event Logs, Events, Show

Operation :
1. Will record all none trip or alarm type events.
2. Time and date stamped.
3. 500 entries with oldest entries being overwritten when full.
4. A "*" symbol will indicate the beginning and end of the list.
5. Can be cleared by gaining login level Engineer and selecting Exit, Menu, event logs, Events, Clear.
6. Use Next and Prev keys to scroll through list.
7. Can be printed to a PC or printer by gaining login level Engineer and selecting Exit, Menu, event logs, Events, Print.



IP7011683

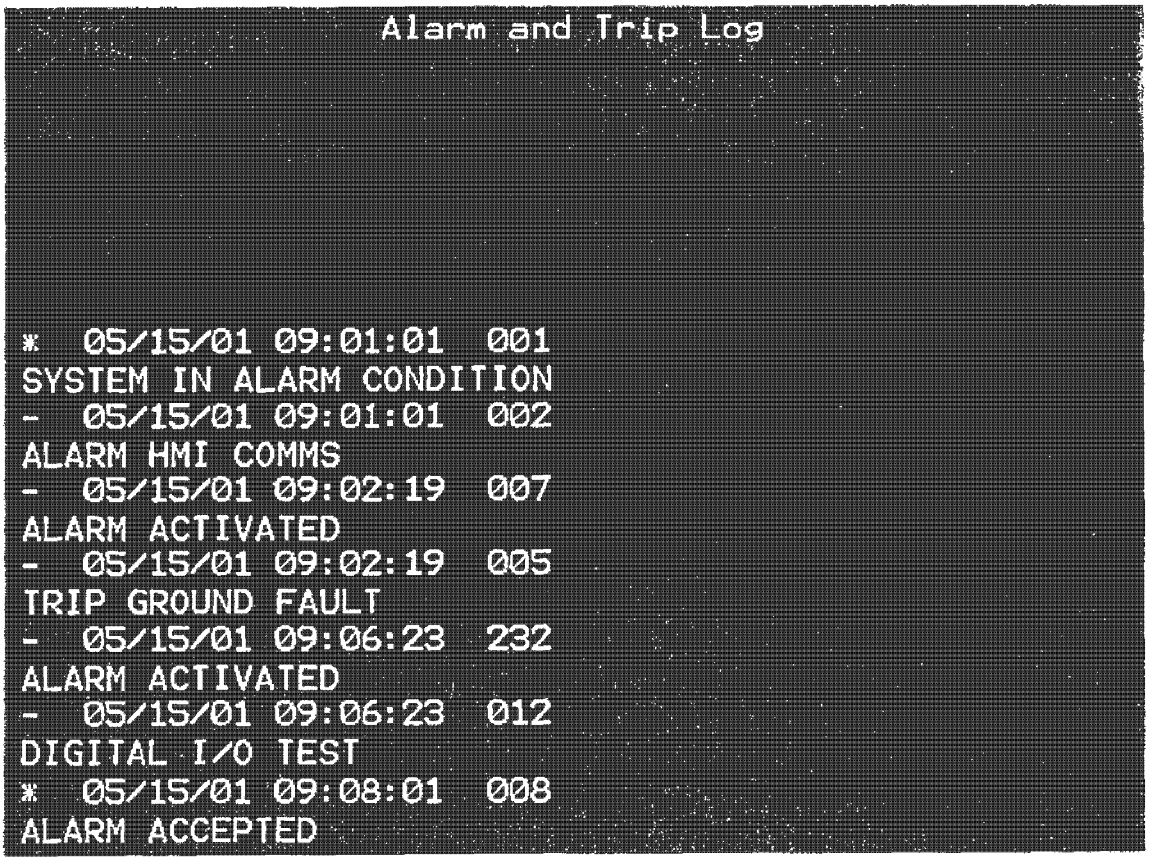
Page.3

Description : Alarm and Trip Log

Access : Any level, Exit, Menu, Event Logs, Alarms, Show

Operation :

1. Will record all trip or alarm type events.
2. Time and date stamped.
3. 500 entries with oldest entries being overwritten when full.
4. A "*" symbol will indicate the beginning and end of the list.
5. Use Next and Prev keys to scroll through list.
6. Can be cleared by gaining login level Engineer and selecting Exit, Menu, event logs, Alarms, Clear.
7. Can be printed to a PC or printer by gaining login level Engineer and selecting Exit, Menu, event logs, Alarms, Print.



IP7011684

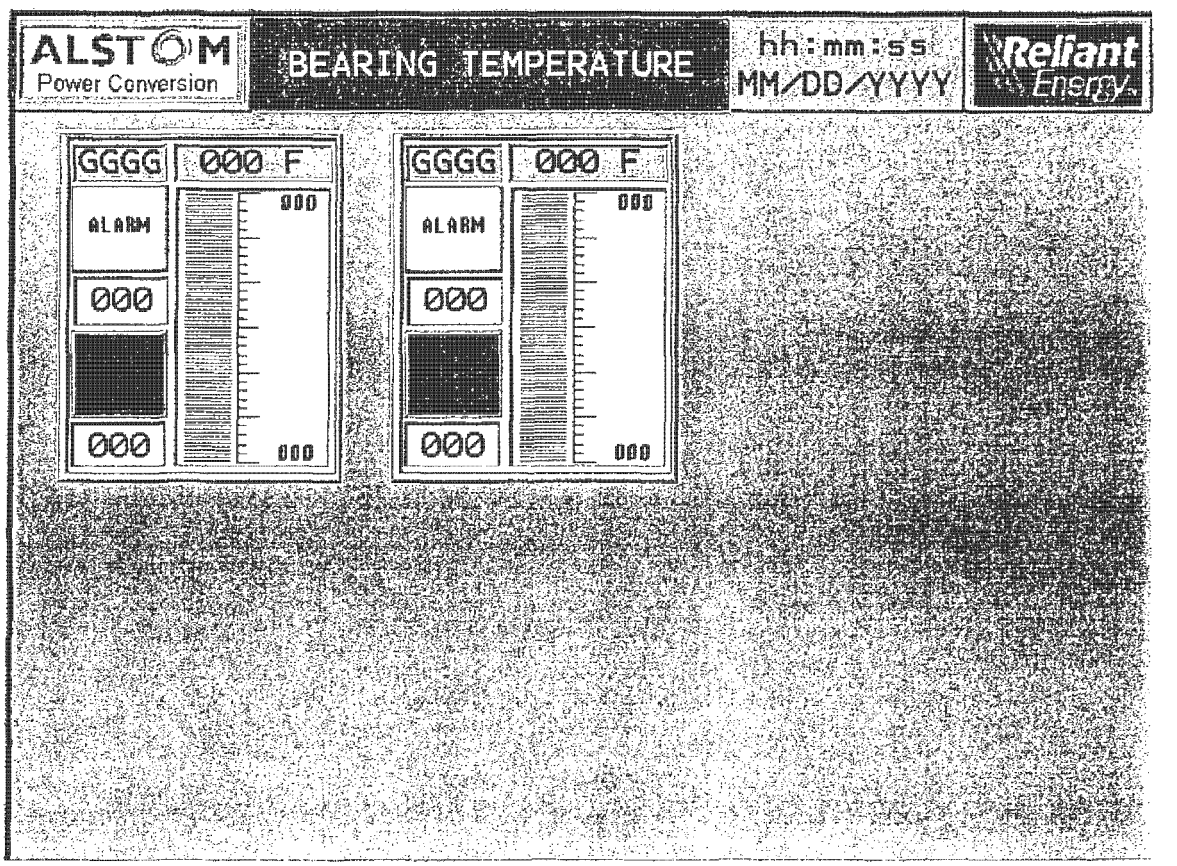
Page.5

Description : Bearing Temperatures

Access : Any level, Exit, Menu, Temp, Bearing

Operation :

1.Bar chart display of Thermocouple feedback.
2.Digital display above bar
3.Individulal setting for Alarm and Trip levels.
4.Alarm will flash yellow if Alarm level exceeded
5.Trip will flash red if Trip level exceeded
6.Bar and title will be green if below alarm level, yellow if greater than alarm level and red if greater than trip level.
7.Alarm and trip event recorded in alarm log and annunciator.
8.Default Alarm level is 194 degrees F
9.Default Trip level is 203 degrees F
10.Use raise/lower/next/prev to modify values.



IP7011685

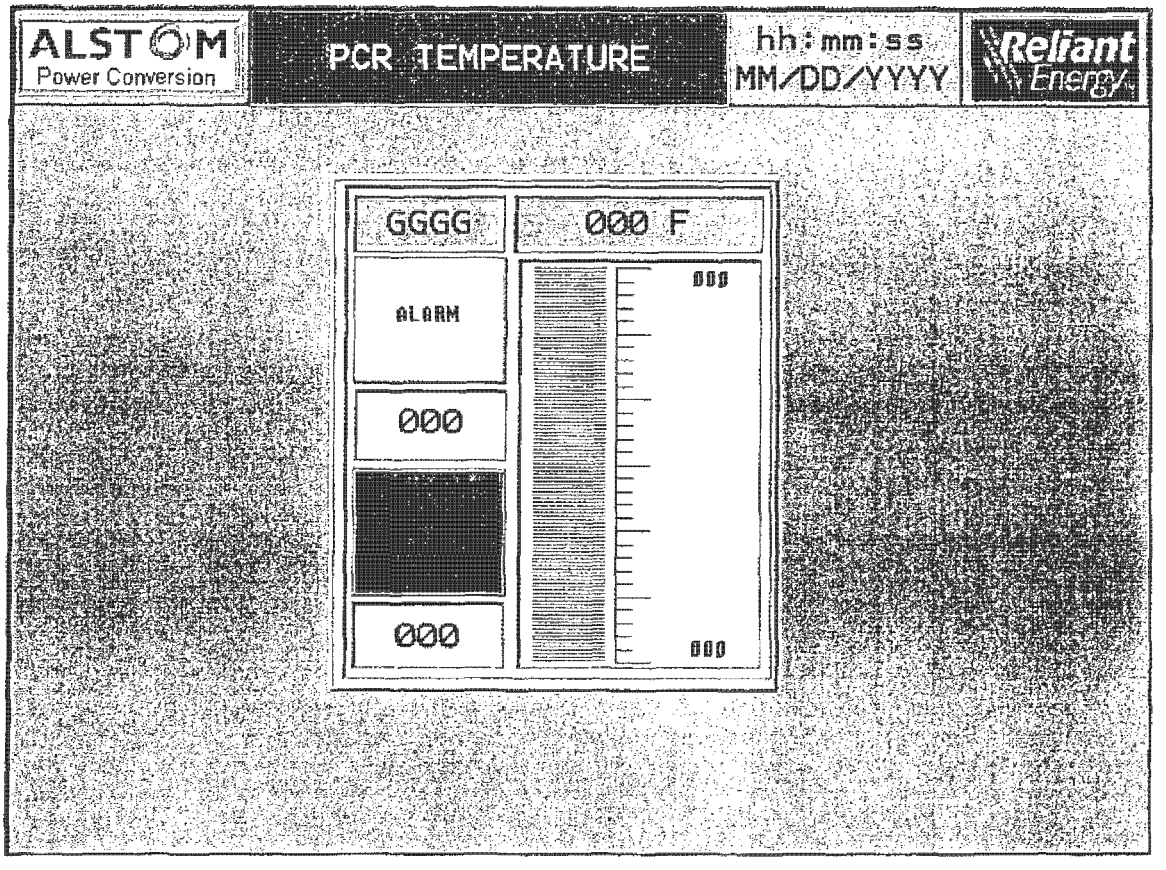
Page.8

Description : PCR Temperature

Access : Any level, Exit, Menu, Temp, PCR

Operation :

1.Bar chart display of RTD feedback.
2.Digital display above bar
3.Individulal setting for Alarm and Trip levels.
4.Alarm will flash yellow if Alarm level exceeded
5.Trip will flash red if Trip level exceeded
6.Bar and title will be green if below alarm level, yellow if greater than alarm level and red if greater than trip level.
7.Alarm and trip event recorded in alarm log and annunciator.
8.Default Alarm level is 80 degrees F
9.Default Trip level is 90 degrees F
10.Use raise/lower/next/prev to modify values.



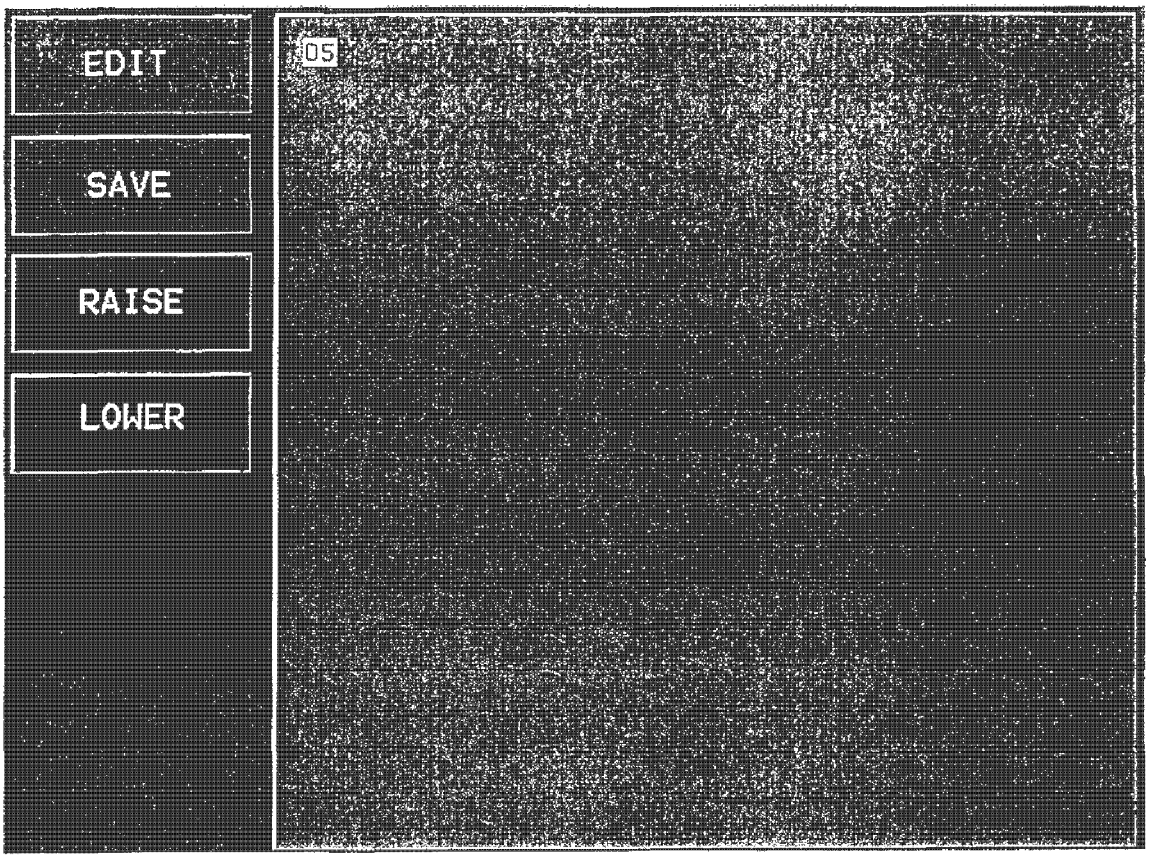
IP7011686

Page.9

Description : Set Time

Access : Engineer Level, EXIT, Menu, Setup, Time

Operation : 1.Adjustment of time and date.
2.Use Raise and Lower keys to adjust items.
3.Use Next and Previous keys to select item.
4.Save and exit when complete.
5.Time and date are downloaded automatically to Sigma every second.



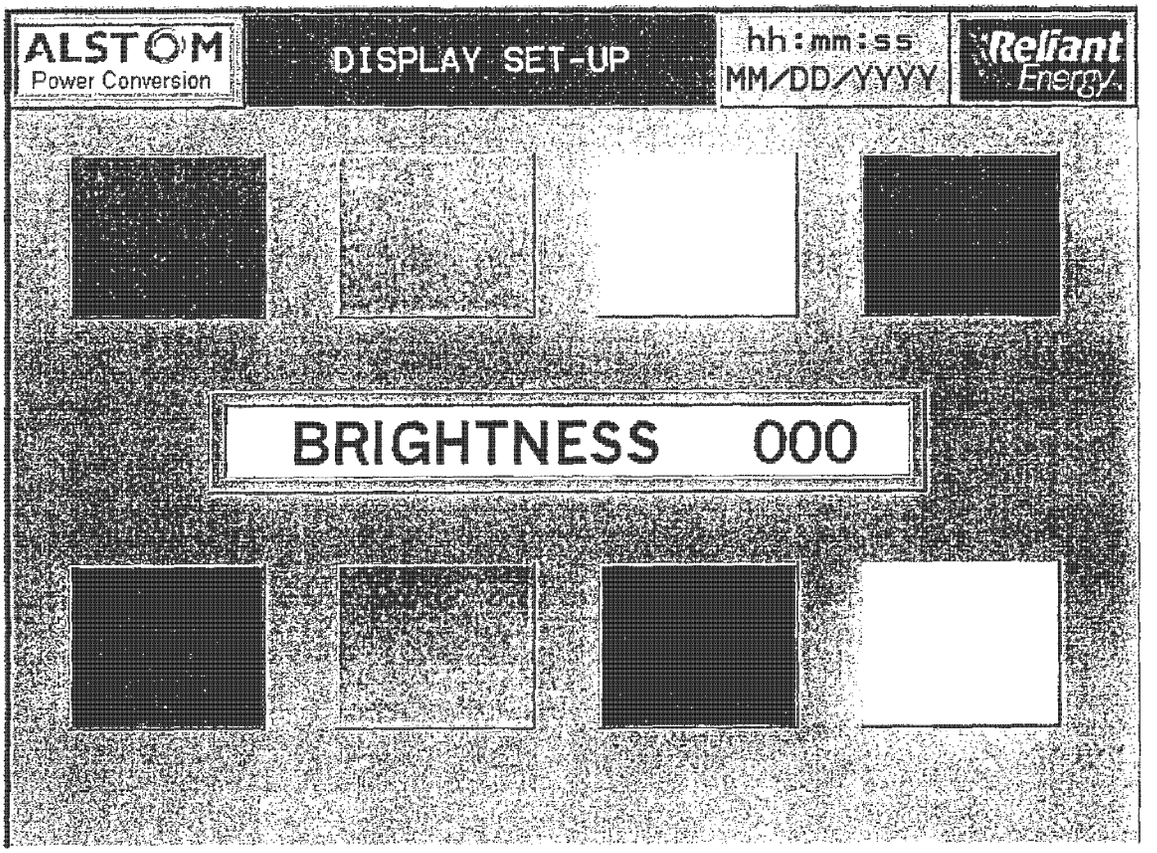
IP7011687

Page.10

Description : Setup Display

Access : Engineer Level, Exit, Menu, Setup, Display

Operation : 1.Use raise and Lower Keys to adjust Brightness.
2.Optimises picture quality for differing viewing angles.



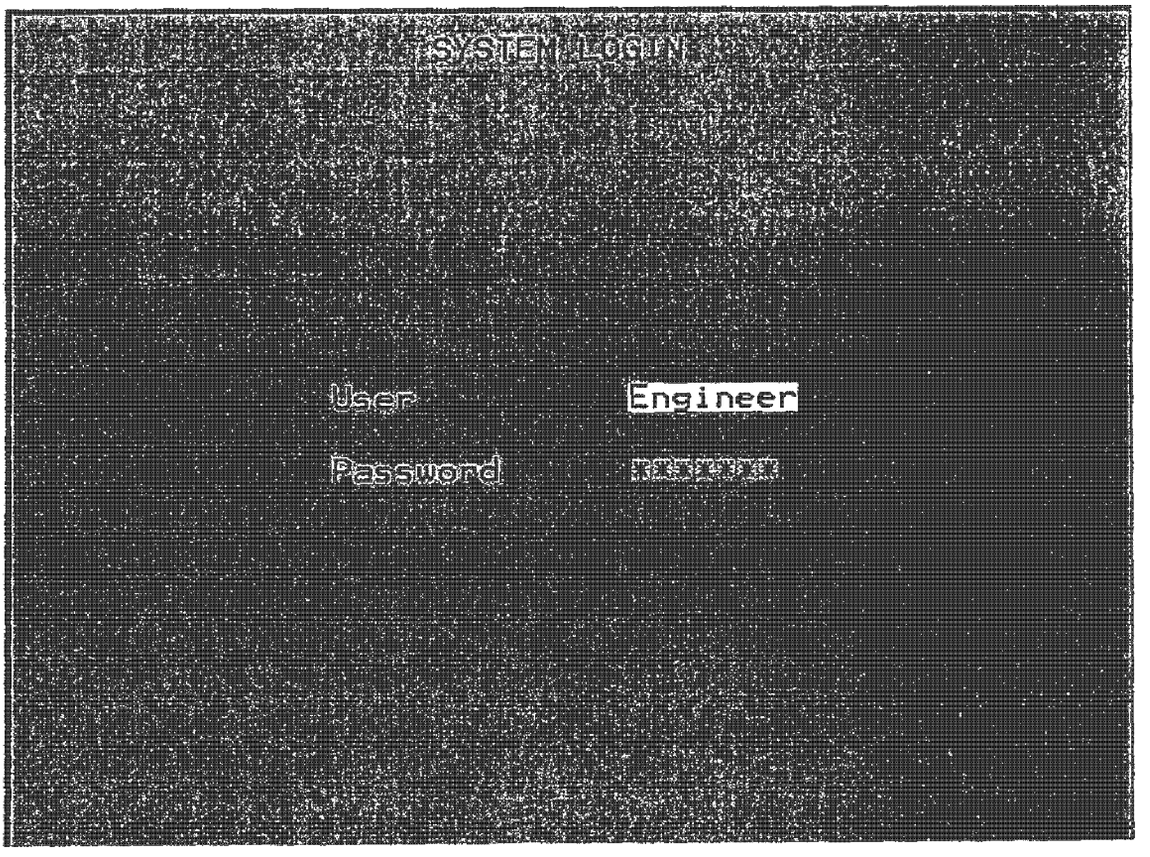
IP7011688

Page.11

Description : User Logon

Access : Any level, Exit, Menu, Logon

Operation :
1.Three user categories defined at present, operator, Engineer and Alstom.
2.Use Raise and Lower or touch to select user status.
3.Use Next and Previous or touch to enter password.
4.Stem will return to previous page when user has successfully logged in.
5.Additional users or categories can be added.



IP7011689

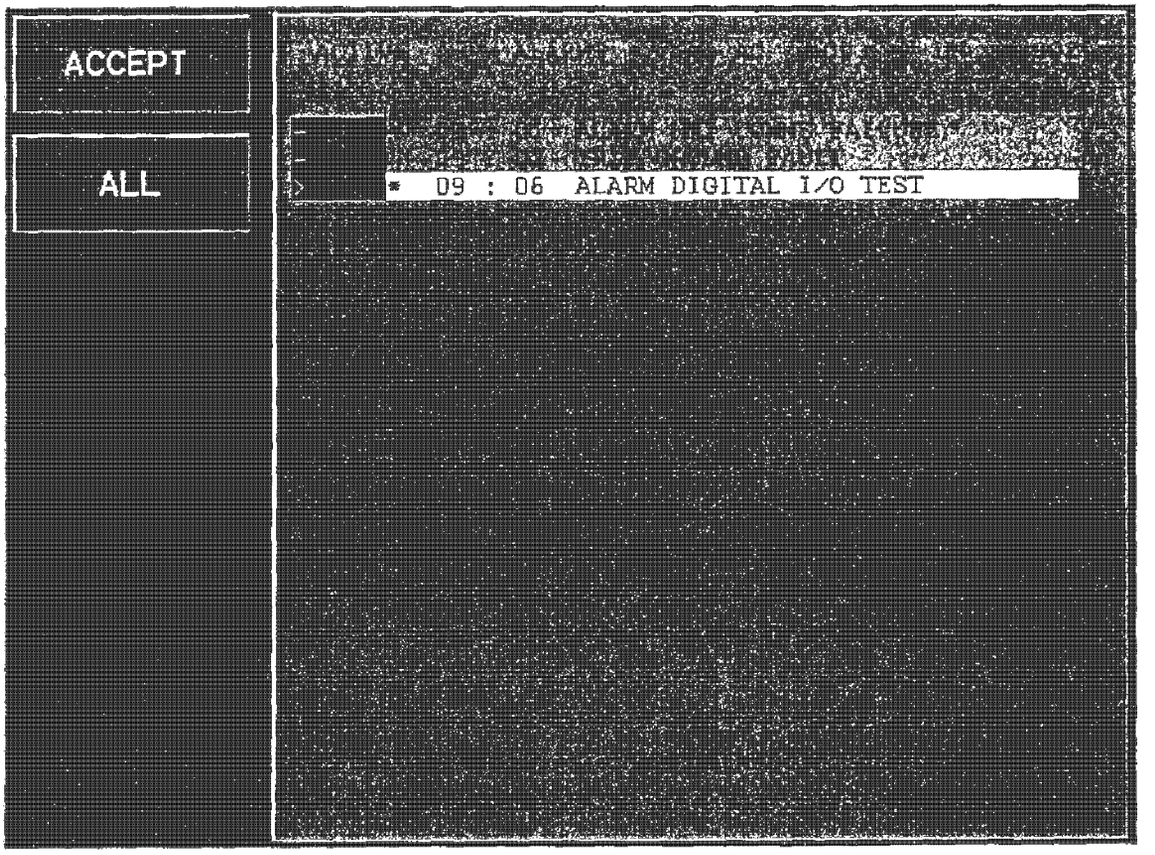
Page.12

Description : Alarm Display

Access : Any level, hit ALARM key from any page

Operation :

1.Individual entries for Trip and Alarm conditions.
2.20 characters of text for each entry.
3.Each entry is time and date stamped.
4.Active none accepted alarms shown in flashing red.
5.Use next and previous to select an item.
6.Use accept to acknowledge an item.
7.Use accept all to acknowledge all items.
8.Entry is removed when no longer active.



IP7011690

6. Trip/Alarm Messages

No.	Displayed Message	Condition that must resolve to TRUE	Details
1	D Convertor Over Current	delta_critical_w1.0	The network bridge current feedback has exceeded the software overcurrent level L12809=1
2	D Breaker Trip Trip & Coast	delta_critical_w1.1	A Trip and coast stop has been generated because of a transformer rapid pressure rise from digital input I:2.4 at the PLC, or the PLC detected that the channel Delta/Wye SW2/8 on the Sigma I/O board was in the incorrect state.
3	D Invertor Over Current	delta_critical_w1.2	The machine bridge current feedback has exceeded the software overcurrent level L12811=1
4	D Local Estop	delta_critical_w1.3	The Red Estop PB on the front of the regulator door has been operated, this is wired to the customer I/o board digital input A2.2
5	D Current Disparity	delta_critical_w1.4	The supply converter and machine inverter current are different by more than +L12832(50%) and -L12833 (50%), L12816=1
6	D Conv/Inver Over Current	delta_critical_w1.5	Both the machine and network bridge current feedbacks have exceeded the software overcurrent level of 130%
7	D HV Doors Open	delta_critical_w1.6	Input A1.7 Monitors series contacts from the HV cabinet doors, this input is low
8	D 52A Beaker Open	delta_critical_w1.7	Input A32.7 Monitors an auxillary contact from the 52 breaker, this input failed to be high after a run was initiated.
9	D critical_w1.8	delta_critical_w1.8	Not used in this system
10	D Hardware Over Current	delta_critical_w1.9	Either converter or inverter current feedback has rapidly risen to approx 300% of rated, this is not sotware controled, the small relay on the Power interface board (mounted on rear of cabinet door) will open.
11	D Overspeed	delta_critical_w1.10	The motor speed feedback L13924 has exceeded the overspeed level W18 (105%), this is derived in software from the encoder feedback in Mode.1 and Stator voltage in Mode.2.
12	D Auto Reset Fail	delta_critical_w1.11	When automatic overcurrent reset is enabled seven attempts are made to reset and run, if a successful run is not achieved then this trip will occur G503.3=0
13	D critical_w1.12	delta_critical_w1.12	Not used in this system

IP7011691

14	D Drive ID Error	delta_critical_w1.13	SW2 on the customer I/o board is used to determine Delta or Wye channel configuration, this switch has 8 individula switches, any combination except for all off or SW2/8 on only will cause this trip. Delta SW2/8=off , Wye SW2/8=on.
15	D Digital OP Test	delta_critical_w1.14	The digital outputs are under the manual control of the commissioning engineer, this is used to force an output to test its operation. M8.0
16	delta_critical_w1.15	delta_critical_w1.15	Not used in this system
17	delta_critical_w2.0	delta_critical_w2.0	Not used in this system
18	delta_critical_w2.1	delta_critical_w2.1	Not used in this system
19	delta_critical_w2.2	delta_critical_w2.2	Not used in this system
20	delta_critical_w2.3	delta_critical_w2.3	Not used in this system
21	delta_critical_w2.4	delta_critical_w2.4	Not used in this system
22	delta_critical_w2.5	delta_critical_w2.5	Not used in this system
23	delta_critical_w2.6	delta_critical_w2.6	Not used in this system
24	delta_critical_w2.7	delta_critical_w2.7	Not used in this system
25	delta_critical_w2.8	delta_critical_w2.8	Not used in this system
26	delta_critical_w2.9	delta_critical_w2.9	Not used in this system
27	delta_critical_w2.10	delta_critical_w2.10	Not used in this system
28	delta_critical_w2.11	delta_critical_w2.11	Not used in this system
29	delta_critical_w2.12	delta_critical_w2.12	Not used in this system
30	delta_critical_w2.13	delta_critical_w2.13	Not used in this system
31	delta_critical_w2.14	delta_critical_w2.14	Not used in this system
32	delta_critical_w2.15	delta_critical_w2.15	Not used in this system
33	Y Convertor Over Current	wye_critical_w1.0	The network bridge current feedback has exceeded the software overcurrent

IP7011692

			level L12809=1
34	Y 52 Brkr Open	wye_critical_w1.1	A Trip and coast stop has been generated because of a transformer rapid pressure rise from digital input I:2.4 at the PLC, or the PLC detected that the channel Delta/Wye SW2/8 on the Sigma I/O board was in the incorrect state.
35	Y Invertor Over Current	wye_critical_w1.2	The machine bridge current feedback has exceeded the software overcurrent level L12811=1
36	Y Local Estop	wye_critical_w1.3	The Red Estop PB on the front of the regulator door has been operated, this is wired to the customer I/o board digital input A2.2
37	Y Current Disparity	wye_critical_w1.4	The supply converter and machine inverter current are different by more than +L12832(50%) and -L12833 (50%), L12816=1
38	Y Conv/Inver Over Current	wye_critical_w1.5	Both the machine and network bridge current feedbacks have exceeded the software overcurrent level of 130%
39	Y HV Doors Open	wye_critical_w1.6	Input A1.7 Monitors series contacts from the HV cabinet doors, this input is low
40	Y 52A Beaker Open	wye_critical_w1.7	Input A32.7 Monitors an auxillary contact from the 52 breaker, this input failed to be high after a run was initiated.
41	wye_critical_w1.8	wye_critical_w1.8	Not used in this system
42	Y Hardware Over Current	wye_critical_w1.9	Either converter or inverter current feedback has rapidly risen to approx 300% of rated, this is not sotware controled, the small relay on the Power interface board (mounted on rear of cabinet door) will open.
43	Y Overspeed	wye_critical_w1.10	The motor speed feedback L13924 has exceeded the overspeed level W18 (105%), this is derived in software from the encoder feedback in Mode.1 and Stator voltage in Mode.2.
44	Y Auto Reset Fail	wye_critical_w1.11	When automatic overcurrent reset is enabled seven attempts are made to reset and run, if a successful run is not achieved then this trip will occur G503.3=0
45	wye_critical_w1.12	wye_critical_w1.12	Not used in this system
46	Y Drive ID Error	wye_critical_w1.13	SW2 on the customer I/o board is used to determine Delta or Wye channel configuration, this switch has 8 individula switches, any combination except for all off or SW2/8 on only will cause this trip. Delta SW2/8=off , Wye SW2/8=on.

IP7011693

47	Y Digital OP Test	wye_critical_w1.14	The digital outputs are under the manual control of the commissioning engineer, this is used to force an output to test its operation. M8.0
48	wye_critical_w1.15	wye_critical_w1.15	Not used in this system
49	wye_critical_w2.0	wye_critical_w2.0	Not used in this system
50	wye_critical_w2.1	wye_critical_w2.1	Not used in this system
51	wye_critical_w2.2	wye_critical_w2.2	Not used in this system
52	wye_critical_w2.3	wye_critical_w2.3	Not used in this system
53	wye_critical_w2.4	wye_critical_w2.4	Not used in this system
54	wye_critical_w2.5	wye_critical_w2.5	Not used in this system
55	wye_critical_w2.6	wye_critical_w2.6	Not used in this system
56	wye_critical_w2.7	wye_critical_w2.7	Not used in this system
57	wye_critical_w2.8	wye_critical_w2.8	Not used in this system
58	wye_critical_w2.9	wye_critical_w2.9	Not used in this system
59	wye_critical_w2.10	wye_critical_w2.10	Not used in this system
60	wye_critical_w2.11	wye_critical_w2.11	Not used in this system
61	wye_critical_w2.12	wye_critical_w2.12	Not used in this system
62	wye_critical_w2.13	wye_critical_w2.13	Not used in this system
63	wye_critical_w2.14	wye_critical_w2.14	Not used in this system
64	wye_critical_w2.15	wye_critical_w2.15	Not used in this system
65	D Gate PSU Fail	delta_none_w1.0	Gate PSU GS1 provides power for the Gate Pulse power modules SA1-3 and MA1-3, this PSU is monitored via digital input A1.2 on the Sigma I/O board, this input is in a LOW state to indicate a trip.
66	D PIB Plug iLock	delta_none_w1.1	One of the plugs fitted to the power interface board has become dislodged. This board is mounted on the rear of the cabinet door
67	D Cooling Fault	delta_none_w1.2	The water cooling system is monitored via digital input A1.4 on the Sigma I/O board, this input has gone Low to indicate a trip. This input is generated by the Cooling System Control PLC using relay CST via output Q10.
68	D PIB Config Error	delta_none_w1.3	The software configuration does not match the power interface board and/or its configuration.
69	D Ground Fault Local stop fault	delta_none_w1.4	Not used in this system
70	D Serial Comms Fail	delta_none_w1.5	Communication between the PLC and the Delta Sigma controller has been lost, this is detected by a "heartbeat" not changing state within a ten second period. This fault was detected by the Drive controller, it should be accompanied by a PLC D comms Fail. Check serial cabling between Prosoft MCM3150 module and Sigma I/O Board.

IP7011694

71	D Mains Sync Loss	delta_none_w1.6	In order to syncronise the network converter pulses the network voltage is monitored via a pt, this voltage is monitored at the power interface board TB308/1 & 2, this level is below 70%.
72	D Motor Breaker Open	delta_none_w1.7	The motor breaker is monitored using an auxillary contact connected to digital input A2.15, if the breaker opens whilst running or fails to close on a start request then G406.0 will be set on to indicate a fault.
73	D Fail to Start	delta_none_w1.8	The drive has been requested to start and the motor has failed to rotate giving a speed feedback greater than 0.25% within W28 (3.5S).
74	D Supply Low V Trip	delta_none_w1.9	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered low if less than data table W29(70%) for W30(200ms) time. The result of this is g300.7 .
75	D Supply High V Trip	delta_none_w1.10	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered high if greater than data table W31(150%) for W32(200ms) time. The result of this is g300.8.
76	D Cooling Flow Fault	delta_none_w1.11	Input A2.11 at the sigma I/O board is low, this input is driven by the cooling system flow monitor FM.
77	D Motor Stall	delta_none_w1.12	Current was greater than 35% and speed was less than 2% for 10 seconds.
78	D Motor I2T Fail	delta_none_w1.13	Motor timed overload has elapsed, this is calculated from change of current with time. The continuous current allowed is
79	D Sigma Early Power Fail	delta_none_w1.14	The sigma power supply PS1 has detected a loss of supply voltage.
80	D Invertor High F Trip	delta_none_w1.15	Motor stator voltage is monitored using two PT's, PT1 and PT2, the secondary is connected using a potential divider to the Power interface board TB315, This input is scaled and will cause a trip if greater than W37 (120%) of rated frequency.
81	D Invertor High V	delta_none_w2.0	Motor stator voltage is monitored using two PT's, PT1 and PT2, the secondary is connected using a potential divider to the Power interface board TB315, This input is scaled and will cause a trip if greater than speed feedback by W35 (60%).

IP7011695

82	D Invertor Low V	delta_none_w2.1	Motor stator voltage is monitored using two PT's, PT1 and PT2, the secondary is connected using a potential divider to the Power interface board TB315, This input is scaled and will cause a trip if less than speed feedback by W33 (40%).
83	D Sigma Watchdog Trip	delta_none_w2.2	Sigma has detected an internal hardware / software self check fault
84	delta_none_w2.3	delta_none_w2.3	Not used in this system
85	D Pos Sensor Fault	delta_none_w2.4	An invalid pattern or pattern transition from the motor positon sensors has been detected, these sensors are monitored via 3 digital inputs A32.1-3 at the Sigma I/I board.
86	D Motor Over Flux	delta_none_w2.5	The motor Voltage to frequency ratio is greater than W22 (140%). The V/F ratio and frequency are determined from the stator voltage feedback a the Power interface board TB315.
87	D Motor Under Flux	delta_none_w2.6	The motor Voltage to frequency ratio is less than W23 (1%). The V/F ratio and frequency are determined from the stator voltage feedback a the Power interface board TB315.
88	D Motor Over V	delta_none_w2.7	The motor stator voltage is greater than W17(115%) of nominal volts. Stator voltage is measured at the power interface board TB315, this is fed from a potential divider circuit from the stator PT's.
89	D EXC 480V Low	delta_none_w2.8	The exciter 480V supply is monitored using a PT which is connected int the power interface board TB308/3 & 4, this is then scaled and will generate a trip if less than 85%.
90	D 12 Pulse TQ REF HI	delta_none_w2.9	When operating as a slave the torque reference is supplied from the other channel via analogue input C14 at the sigma analogue I/O board TB17, this input has exceeded 9V, a value of 6V represents 150% demand of nominal.
91	D 12 Pulse TQ REF LO	delta_none_w2.10	When operating as a slave the torque reference is supplied from the other channel via analogue input C14 at the sigma analogue I/O board TB17, this input has falled to less than 1.4V, a value of 2V represents 0% demand of nominal.
92	D Distrib Plug ILOCK	delta_none_w2.11	A connection between the Power interface board PL301/303 and/or the Pulse amplifier boards PL1 and/or the Distribution board PL1 is not correctly made. Check all connections.

IP7011696

93	D Pulse Amp Plug ILOCK	delta_none_w2.12	A connection between the Power interface board PL301/303 and/or the Pulse amplifier boards PL1 and/or the Distribution board PL1 is not correctly made. Check all connections.
94	D AC Surge Fault	delta_none_w2.13	Digital input A1.5 at the sigma I/O borad is used to monitor the status of the drive supply surge circuit fuses. The input to the surge circuit is monitored via 3 CT's, these are connected into current inbalance relay which controls a normally open dry contact. This input is not checkedd unless the breaker is closed.
95	D DC Reactor Trip	delta_none_w2.14	Digital input A2.6 at the sigma I/O board is connected to a normally open contact from the DC link reactor. This contact will be closed if Healthy and open at 200 C trip level.
96	D WatchDOG RL Trip	delta_none_w2.15	digital input A2.13 at the sigma I/O board is connected to a normally open contact from the DOG relay. This relay is energised from a normally open contact from the PSOK relay. The PSOK relay is a result of the PS1-4OK relays being energised. This digital input A2.13 has gone low.
97	Y Gate PSU Fail	wye_none_w1.0	Gate PSU GS1 provides power for the Gate Pulse power modules SA1-3 and MA1-3, this PSU is monitored via digital input A1.2 on the Sigma I/O board, this input is in a LOW state to indicate a trip.
98	Y PIB Plug ILock	wye_none_w1.1	One of the plugs fitted to the power interface board has become dislodged. This board is mounted on the rear of the cabinet door
99	Y Cooling Fault	wye_none_w1.2	The water cooling system is monitored via digital input A1.4 on the Sigma I/O board, this input has gone Low to indicate a trip. This input is generated by the Cooling System Control PLC using relay CST via output Q10.
100	Y PIB Config Error	wye_none_w1.3	The software configuration does not match the power interface board and/or its configuration.
101	Y Ground Fault	wye_none_w1.4	Not used in this system
102	Y Serial Comms Fail	wye_none_w1.5	Communication between the PLC and the Delta Sigma controller has been lost, this is detected by a "heartbeat" not changing state within a ten second period. This fault was detected by the Drive controller, it should be accompanied by a PLC D comms Fail. Check serial cabling between Prosoft

IP7011697

			MCM3150 module and Sigma I/O Board.
103	Y Mains Sync Loss	wye_none_w1.6	In order to syncronise the network converter pulses the network voltage is monitored via a pt, this voltage is monitored at the power interface board TB308/1 & 2, this level is below 70%.
104	Y Motor Breaker Open	wye_none_w1.7	The motor breaker is monitored using an auxillary contact connected to digital input A2.15, if the breaker opens whilst running or fails to close on a start request then G406.0 will be set on to indicate a fault.
105	Y Fail to Start	wye_none_w1.8	The drive has been requested to start and the motor has failed to rotate giving a speed feedback greater than 0.25% within W28 (3.5S).
106	Y Supply Low V Trip	wye_none_w1.9	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered low if less than data table W29(70%) for W30(200ms) time. The result of this is g300.7 .
107	Y Supply High V Trip	wye_none_w1.10	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered high if greater than data table W31(150%) for W32(200ms) time. The result of this is g300.8.
108	Y Cooling Flow Fault	wye_none_w1.11	Input A2.11 at the sigma I/O board is low, this input is driven by the cooling system flow monitor FM.
109	Y Motor Stall	wye_none_w1.12	Current was greater than 35% and speed was less than 2% for 10 seconds.
110	Y Motor I2T Fail	wye_none_w1.13	Motor timed overload has elapsed, this is calculated from change of current with time. The continuous current allowed is
111	Y Sigma Early Power Fail	wye_none_w1.14	The sigma power supply PS1 has detected a loss of supply voltage.
112	Y Invertor High F Trip	wye_none_w1.15	Motor stator voltage is monitored using two PT's, PT1 and PT2, the secondary is connected using a potential divider to the Power interface board TB315, This input is scaled and will cause a trip if greater than W37 (120%) of rated frequency.

IP7011698

113	Y Invertor High V	wye_none_w2.0	Motor stator voltage is monitored using two PT's, PT1 and PT2, the secondary is connected using a potential divider to the Power interface board TB315, This input is scaled and will cause a trip if greater than speed feedback by W35 (60%).
114	Y Invertor Low V	wye_none_w2.1	Motor stator voltage is monitored using two PT's, PT1 and PT2, the secondary is connected using a potential divider to the Power interface board TB315, This input is scaled and will cause a trip if less than speed feedback by W33 (40%).
115	Y Sigma Watchdog Trip	wye_none_w2.2	Sigma has detected an internal hardware / software self check fault
116	Y WatchDOG RL Trip	wye_none_w2.3	Not used in this system
117	Y Pos Sensor Fault	wye_none_w2.4	An invalid pattern or pattern transition from the motor positon sensors has been detected, these sensors are monitored via 3 digital inputs A32.1-3 at the Sigma I/I board.
118	Y Motor Over Flux	wye_none_w2.5	The motor Voltage to frequency ratio is greater than W22 (140%). The V/F ratio and frequency are determined from the stator voltage feedback a the Power interface board TB315.
119	Y Motor Under Flux	wye_none_w2.6	The motor Voltage to frequency ratio is less than W23 (1%). The V/F ratio and frequency are determined from the stator voltage feedback a the Power interface board TB315.
120	Y Motor Over V	wye_none_w2.7	The motor stator voltage is greater than W17(115%) of nominal volts. Stator voltage is measured at the power interface board TB315, this is fed from a potential divider circuit from the stator PT's.
121	Y EXC 480V Low	wye_none_w2.8	The exciter 480V supply is monitored using a PT which is connected int the power interface board TB308/3 & 4, this is then scaled and will generate a trip if less than 85%.
122	Y 12 Pulse TQ REF HI	wye_none_w2.9	When operating as a slave the torque reference is supplied from the other channel via analogue input C14 at the sigma analogue I/O board TB17, this input has exceeded 9V, a value of 6V represents 150% demand of nominal.
123	Y 12 Pulse TQ REF LO	wye_none_w2.10	When operating as a slave the torque reference is supplied from the other channel via analogue input C14 at the sigma analogue I/O board TB17, this input has falled to less than 1.4V, a

IP7011699

			value of 2V represents 0% demand of nominal.
124	Y Distrib Plug ILOCK	wye_none_w2.11	A connection between the Power interface board PL301/303 and/or the Pulse amplifier boards PL1 and/or the Distribution board PL1 is not correctly made. Check all connections.
125	Y Pulse Amp Plug ILOCK	wye_none_w2.12	A connection between the Power interface board PL301/303 and/or the Pulse amplifier boards PL1 and/or the Distribution board PL1 is not correctly made. Check all connections.
126	Y AC Surge Fault	wye_none_w2.13	Digital input A1.5 at the sigma I/O borad is used to monitor the status of the drive supply surge circuit fuses. The input to the surge circuit is monitored via 3 CT's, these are connected into current inbalance relay which controls a normally open dry contact. This input is not checkedd unless the breaker is closed.
127	Y DC Reactor Trip	wye_none_w2.14	Digital input A2.6 at the sigma I/O board is connected to a normally open contact from the DC link reactor. This contact will be closed if Healthy and open at 200 C trip level.
128	Y WatchDOG RL Trip	wye_none_w2.15	digital input A2.13 at the sigma I/O board is connected to a normally open contact from the DOG relay. This relay is energised from a normally open contact from the PSOK relay. The PSOK relay is a result of the PS1-4OK relays being energised. This digital input A2.13 has gone low.
129	D Sigma Battery Low	delta_alarm_w1.0	The batteries located behind the Alstom blanking panel on the front of the sigma assembly need to be replaced, they are accessed by removing the two screws on the blanking panel, this can be done whilst the system is powered up and running.
130	D Start Permissive	delta_alarm_w1.1	No start permissive from the PLC is being sent to the drives. This permissive is continuoulsy set high and is not set from any external inputs.
131	D Cooling Sys Alarm	delta_alarm_w1.2	Digital input A1.3 at the sigma I/O board is low, this input is fed from the cooling system controller CSC relay CSA which is connected to digital output Q11.

IP7011700

132	D Mode 2 Encoder Alarm	delta_alarm_w1.3	An invalid pattern or pattern transition from the motor positon sensors has been detected, these sensors are monitored via 3 digital inputs A32.1-3 at the Sigma I/I board.
133	D Supply Low V Alarm	delta_alarm_w1.4	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered low if less than data table W304(85%) for W306(100ms) time. The result of this is g301.7 .
134	D Supply High V Alarm	delta_alarm_w1.5	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered high if greater than data table W308(110%) for W309(100ms) time. The result of this is g301.8.
135	D Supply Over I	delta_alarm_w1.6	The supply current has exceeded 130% of nominal current. L12809 will be latched to 1. This is generated by the monitoring of the supply CT's connected to the power interface board TB311/1-4
136	D Machine Over I	delta_alarm_w1.7	The machine current has exceeded 130% of nominal current. L12811 will be latched to 1. This is generated by the monitoring of the machine CT's connected to the power interface board TB311/5-8.
137	D Ground Fault	delta_alarm_w1.8	Digital input A32.0 at the Sigma customer I/O board is connected to the ground fault relay at the motor power cables. This input has gone low which indicates a ground fault current of 100mA through the relay.
138	delta_alarm_w1.9	delta_alarm_w1.9	Not used in this system
139	D Exc Over Current	delta_alarm_w1.10	Exciter current feedback is measured using 3 CT's which are connected to the power interface board TB312/11-14. This input is scaled and has risen to a value greater than W20 (130%) . G51.7 will go to zero to indicate this.
140	D Exc Under Current	delta_alarm_w1.11	Exciter current feedback is measured using 3 CT's which are connected to the power interface board TB312/11-14. This input is scaled and has fallen to a value less than W20 (5%) . G51.8 will go to a zero to indicate this.
141	D Pulse Amp PSU Alarm	delta_alarm_w1.12	Pulse amplifier boards PAB1 or PAB2 has detected that the internal power rails are not healthy. This could be due to a faulty unit, bad external power to the unit or incorrect connection of cabling between pulse amplifier and power

IP7011701

			interface board. Check external power supplies and correct fitting of all cables.
142	D Diagnostic Link Fail	delta_alarm_w1.13	
143	D HDLC Card Fail	delta_alarm_w1.14	
144	D Diagnostic Data Fail	delta_alarm_w1.15	
145	D Gate PSU Alarm	delta_alarm_w2.0	Gate PSU GS1 provides power for the Gate Pulse power modules SA1-3 and MA1-3, this PSU is monitored via digital input A1.1 on the Sigma I/O board, this input is in a LOW state to indicate an alarm.
146	D DC Reactor Alarm	delta_alarm_w2.1	Digital input A2.5 at the sigma I/O board is connected to a normally open contact from the DC link reactor. This contact will be closed if Healthy and open at 190 C alarm level.
147	D External Lock Out	delta_alarm_w2.2	Digital input A2.14 at the M80 expanded I/o board monitors the external 24V control supply. This supply is connected to TB1/11, which in turn drives relay LOCK, a normally open contact of LOCK connects into input A2.14, this input has gone low.
148	D HDLC Iinit Fail	delta_alarm_w2.3	
149	delta_alarm_w2.4	delta_alarm_w2.4	Not used in this system
150	delta_alarm_w2.5	delta_alarm_w2.5	Not used in this system
151	delta_alarm_w2.6	delta_alarm_w2.6	Not used in this system
152	delta_alarm_w2.7	delta_alarm_w2.7	Not used in this system
153	delta_alarm_w2.8	delta_alarm_w2.8	Not used in this system
154	delta_alarm_w2.9	delta_alarm_w2.9	Not used in this system
155	delta_alarm_w2.10	delta_alarm_w2.10	Not used in this system
156	delta_alarm_w2.11	delta_alarm_w2.11	Not used in this system
157	delta_alarm_w2.12	delta_alarm_w2.12	Not used in this system
158	delta_alarm_w2.13	delta_alarm_w2.13	Not used in this system
159	delta_alarm_w2.14	delta_alarm_w2.14	Not used in this system
160	delta_alarm_w2.15	delta_alarm_w2.15	Not used in this system
161	Y Sigma Battery Low	wye_alarm_w1.0	The batteries located behind the Alstom blanking panel on the front of the sigma assembly need to be replaced, they are accessed by removing the two screws on the blanking panel, this can be done whilst the system is powered up and running.
162	Y Start Permissive	wye_alarm_w1.1	No start permissive from the PLC is being sent to the drives. This permissive is continuoulsy set high and is not set from any external inputs.

IP7011702

163	Y Cooling Sys Alarm	wye_alarm_w1.2	Digital input A1.3 at the sigma I/O board is low, this input is fed from the cooling system controller CSC relay CSA which is connected to digital output Q11.
164	Y Mode 2 Encoder Alarm	wye_alarm_w1.3	An invalid pattern or pattern transition from the motor positon sensors has been detected, these sensors are monitored via 3 digital inputs A32.1-3 at the Sigma I/I board.
165	Y Supply Low V Alarm	wye_alarm_w1.4	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered low if less than data table W304(85%) for W306(100ms) time. The result of this is g301.7 .
166	Y Supply High V Alarm	wye_alarm_w1.5	The Supply HV is monitored via a PT and connected to the Power interface Board TB308/1 & 2. This input is scaled and will be considered high if greater than data table W308(110%) for W309(100ms) time. The result of this is g301.8.
167	Y Supply Over I	wye_alarm_w1.6	The supply current has exceeded 130% of nominal current. L12809 will be latched to 1. This is generated by the monitoring of the supply CT's connected to the power interface board TB311/1-4
168	Y Machine Over I	wye_alarm_w1.7	The machine current has exceeded 130% of nominal current. L12811 will be latched to 1. This is generated by the monitoring of the machine CT's connected to the power interface board TB311/5-8.
169	Y Ground Fault	wye_alarm_w1.8	Digital input A32.0 at the Sigma customer I/O board is connected to the ground fault relay at the motor power cables. This input has gone low which indicates a ground fault current of 100mA through the relay.
170	wye_alarm_w1.9	wye_alarm_w1.9	Not used in this system
171	Y Exc Over Current	wye_alarm_w1.10	Exciter current feedback is measured using 3 CT's which are connected to the power interface board TB312/11-14. This input is scaled and has risen to a value greater than W20 (130%) . G51.7 will go to zero to indicate this.
172	Y Exc Under Current	wye_alarm_w1.11	Exciter current feedback is measured using 3 CT's which are connected to the power interface board TB312/11-14. This input is scaled and has fallen to a value less than W20 (5%) . G51.8 will go to a zero to indicate this.

IP7011703

173	Y Pulse Amp PSU Alarm	wye_alarm_w1.12	Pulse amplifier boards PAB1 or PAB2 has detected that the internal power rails are not healthy. This could be due to a faulty unit, bad external power to the unit or incorrect connection of cabling between pulse amplifier and power interface board. Check external power supplies and correct fitting of all cables.
174	Y Diagnostic Link Fail	wye_alarm_w1.13	
175	Y HDLC Card Fail	wye_alarm_w1.14	
176	Y Diagnostic Data Fail	wye_alarm_w1.15	
177	Y Gate PSU Alarm	wye_alarm_w2.0	Gate PSU GS1 provides power for the Gate Pulse power modules SA1-3 and MA1-3, this PSU is monitored via digital input A1.1 on the Sigma I/O board, this input is in a LOW state to indicate an alarm.
178	Y DC Reactor Alarm	wye_alarm_w2.1	Digital input A2.5 at the sigma I/O board is connected to a normally open contact from the DC link reactor. This contact will be closed if Healthy and open at 190 C alarm level.
179	Y External Lock Out	wye_alarm_w2.2	Digital input A2.14 at the M80 expanded I/o board monitors the external 24V control supply. This supply is connected to TB1/11, which in turn drives relay LOCK, a normally open contact of LOCK connects into input A2.14, this input has gone low.
180	Y HDLC Init Fail	wye_alarm_w2.3	
181	wye_alarm_w2.4	wye_alarm_w2.4	Not used in this system
182	wye_alarm_w2.5	wye_alarm_w2.5	Not used in this system
183	wye_alarm_w2.6	wye_alarm_w2.6	Not used in this system
184	wye_alarm_w2.7	wye_alarm_w2.7	Not used in this system
185	wye_alarm_w2.8	wye_alarm_w2.8	Not used in this system
186	wye_alarm_w2.9	wye_alarm_w2.9	Not used in this system
187	wye_alarm_w2.10	wye_alarm_w2.10	Not used in this system
188	wye_alarm_w2.11	wye_alarm_w2.11	Not used in this system
189	wye_alarm_w2.12	wye_alarm_w2.12	Not used in this system
190	wye_alarm_w2.13	wye_alarm_w2.13	Not used in this system
191	wye_alarm_w2.14	wye_alarm_w2.14	Not used in this system
192	wye_alarm_w2.15	wye_alarm_w2.15	Not used in this system
193	Bearing TC.1 Alarm	temp_tc1>=tc1_alarm_level	The measured bearing temperature has exceeded the alarm level set on the bearing temp page of the HMI.
194	Bearing TC.2 Alarm	temp_tc2>=tc2_alarm_level	The measured bearing temperature has exceeded the alarm level set on the bearing temp page of the HMI.
195	Winding RTD.1 Alarm	temp_rtd1>=rtd1_alarm_level	The measured winding temperature has exceeded the alarm level set on the winding temp page of the HMI.

IP7011704

196	Winding RTD.2 Alarm	temp_rtd2>=rtd2_alarm_level	The measured winding temperature has exceeded the alarm level set on the winding temp page of the HMI.
197	Winding RTD.3 Alarm	temp_rtd3>=rtd3_alarm_level	The measured winding temperature has exceeded the alarm level set on the winding temp page of the HMI.
198	Winding RTD.4 Alarm	temp_rtd4>=rtd4_alarm_level	The measured winding temperature has exceeded the alarm level set on the winding temp page of the HMI.
199	Winding RTD.5 Alarm	temp_rtd5>=rtd5_alarm_level	The measured winding temperature has exceeded the alarm level set on the winding temp page of the HMI.
200	Winding RTD.6 Alarm	temp_rtd6>=rtd6_alarm_level	The measured winding temperature has exceeded the alarm level set on the winding temp page of the HMI.
201	Bearing TC.1 Trip	temp_tc1>=tc1_trip_level	The measured bearing temperature has exceeded the trip level set on the bearing temp page of the HMI.
202	Bearing TC.2 Trip	temp_tc2>=tc2_trip_level	The measured bearing temperature has exceeded the trip level set on the bearing temp page of the HMI.
203	Winding RTD.1 Trip	temp_rtd1>=rtd1_trip_level	The measured winding temperature has exceeded the trip level set on the winding temp page of the HMI.
204	Winding RTD.2 Trip	temp_rtd2>=rtd2_trip_level	The measured winding temperature has exceeded the trip level set on the winding temp page of the HMI.
205	Winding RTD.3 Trip	temp_rtd3>=rtd3_trip_level	The measured winding temperature has exceeded the trip level set on the winding temp page of the HMI.
206	Winding RTD.4 Trip	temp_rtd4>=rtd4_trip_level	The measured winding temperature has exceeded the trip level set on the winding temp page of the HMI.
207	Winding RTD.5 Trip	temp_rtd5>=rtd5_trip_level	The measured winding temperature has exceeded the trip level set on the winding temp page of the HMI.
208	Winding RTD.6 Trip	temp_rtd6>=rtd6_trip_level	The measured winding temperature has exceeded the trip level set on the winding temp page of the HMI.
209	Untitled	Manual	Not used in this system
210	PLC D Comm Fail	delta_com_fail	Communication between the PLC and the Delta Sigma controller has been lost, this is detected by a "heartbeat" not changing state within a ten second period. This fault was detected by the PLC. Check serial cabling between Prosoft MCM3150 module and Sigma I/O Board.

IP7011705

211	PLC Y Comm Fail	wye_com_fail	Communication between the PLC and the Wye Sigma controller has been lost, this is detected by a "heartbeat" not changing state within a ten second period. This fault was detected by the PLC. Check serial cabling between Prosoft MCM3150 module and Sigma I/O Board.
212	System Alarm	system_alarm	Any motor, transformer or drive alarm or trip will generate this general alarm. It will be accompanied by relevant individual alram or trip.
213	Untitled	Manual	Not used in this system
214	ID Fan Tripped	id_fan_tripped	Both drives have tripped in Remote mode, or a single drive has tripped in remote whilst the other drive was in local, or both drives are in local. This is a direct reflection of PLC output O:7.2
215	PCR High Temp Trip	pcr_hi_temp	PLC digital input I:3.0 has been high for more than 2 seconds, this reflects a PCR high temperature alarm.
216	Mot Diff Pressure	diff_press	PLC digital input I:3.7 has been high for more than 2 seconds, this reflects a Motor differential pressure high alarm.
217	400A Transfer Alarm	tran_switch	PLC digital input I:2.10 has gone high to indicate that the 400A 480V transfer switch is in the emergency position, that is to say that the primary 480V supply has been lost.
218	Speed Ref Loss	ref_loss	The PLC speed ref I:8.0 has fallen below 4mA
219	UPS Alarm	ups_alarm	PLC digital input I:3.6 has gone high to indicate that the 120V supply UPS is in Alarm condition.
220	XFMR Rapid Pessure	xfmr_rapid_press	PLC digital input I:2.4 has gone high to indicate that the transformer rapid pressure rise relay has energised..
221	XFMR Pressure Alarm	xfmr_press_alarm	PLC digital input I:2.3 has gone high to indicate that the transformer high pressure alarm relay has energised..
222	XFMR Vacuum Alarm	xfmr_vac_alarm	PLC digital input I:2.5 has gone high to indicate that the transformer vacuum alarm relay has energised..
223	XFMR Pressure Relief	xfmr_press_relief	PLC digital input I:2.6 has gone high to indicate that the transformer pressure relief device has operated.
224	XFMR Low Oil	xfmr_low_liquid	PLC digital input I:2.2 has gone high to indicate that the transformer coolant level is low.
225	XFMR Oil Temp Alarm	xfmr_liquid_talarm	PLC digital input I:2.7 has gone high to indicate that the transformer oil temperature has reached alarm level

IP7011706

226	XFMR Oil Temp Trip	xfmr_liquid_ttrip	PLC digital input I:2.8 has gone high to indicate that the transformer oil temperature has reached trip level
227	XFMR Winding Temp Alarm	xfmr_wind_alarm	PLC digital input I:2.1 has gone high to indicate that the transformer winding temperature has reached alarm level.
228	XFMR Winding Temp Trip	xfmr_wind_trip	PLC digital input I:2.9 has gone high to indicate that the transformer winding temperature has reached trip level.
229	Delta SW2.1 Not OFF SW2.8	delta_config_error	Delta drive sigma I/O board SW2/8 should always be off, it has been detected as on.
230	Wye SW2.1 Not ON SW2.8	wye_config_error	Wye drive sigma I/O board SW2/8 should always be on, it has been detected as off.
231	Untitled	Manual	Not used in this system
232	Untitled	Manual	Not used in this system
233	Untitled	Manual	Not used in this system
234	Untitled	Manual	Not used in this system
235	Untitled	Manual	Not used in this system
236	Untitled	Manual	Not used in this system
237	Untitled	Manual	Not used in this system
238	Untitled	Manual	Not used in this system
239	Untitled	Manual	Not used in this system
240	Untitled	Manual	Not used in this system
241	delta_cnvdiag_alarms.0	delta_cnvdiag_alarms.0	see drive keypad for information
242	delta_cnvdiag_alarms.1	delta_cnvdiag_alarms.1	see drive keypad for information
243	delta_cnvdiag_alarms.2	delta_cnvdiag_alarms.2	see drive keypad for information
244	delta_cnvdiag_alarms.3	delta_cnvdiag_alarms.3	see drive keypad for information
245	delta_cnvdiag_alarms.4	delta_cnvdiag_alarms.4	see drive keypad for information
246	delta_cnvdiag_alarms.5	delta_cnvdiag_alarms.5	see drive keypad for information
247	delta_cnvdiag_alarms.6	delta_cnvdiag_alarms.6	see drive keypad for information
248	delta_cnvdiag_alarms.7	delta_cnvdiag_alarms.7	see drive keypad for information
249	delta_cnvdiag_alarms.8	delta_cnvdiag_alarms.8	see drive keypad for information
250	delta_cnvdiag_alarms.9	delta_cnvdiag_alarms.9	see drive keypad for information
251	delta_cnvdiag_alarms.10	delta_cnvdiag_alarms.10	see drive keypad for information
252	delta_cnvdiag_alarms.11	delta_cnvdiag_alarms.11	see drive keypad for information

IP7011707

253	delta_cnvdiag_alarms.12	delta_cnvdiag_alarms.12	see drive keypad for information
254	delta_cnvdiag_alarms.13	delta_cnvdiag_alarms.13	see drive keypad for information
255	delta_cnvdiag_alarms.14	delta_cnvdiag_alarms.14	see drive keypad for information
256	delta_cnvdiag_alarms.15	delta_cnvdiag_alarms.15	see drive keypad for information
257	delta_cnvdiag_faults.0	delta_cnvdiag_faults.0	see drive keypad for information
258	delta_cnvdiag_faults.1	delta_cnvdiag_faults.1	see drive keypad for information
259	delta_cnvdiag_faults.2	delta_cnvdiag_faults.2	see drive keypad for information
260	delta_cnvdiag_faults.3	delta_cnvdiag_faults.3	see drive keypad for information
261	delta_cnvdiag_faults.4	delta_cnvdiag_faults.4	see drive keypad for information
262	delta_cnvdiag_faults.5	delta_cnvdiag_faults.5	see drive keypad for information
263	delta_cnvdiag_faults.6	delta_cnvdiag_faults.6	see drive keypad for information
264	delta_cnvdiag_faults.7	delta_cnvdiag_faults.7	see drive keypad for information
265	delta_cnvdiag_faults.8	delta_cnvdiag_faults.8	see drive keypad for information
266	delta_cnvdiag_faults.9	delta_cnvdiag_faults.9	see drive keypad for information
267	delta_cnvdiag_faults.10	delta_cnvdiag_faults.10	see drive keypad for information
268	delta_cnvdiag_faults.11	delta_cnvdiag_faults.11	see drive keypad for information
269	delta_cnvdiag_faults.12	delta_cnvdiag_faults.12	see drive keypad for information
270	delta_cnvdiag_faults.13	delta_cnvdiag_faults.13	see drive keypad for information
271	delta_cnvdiag_faults.14	delta_cnvdiag_faults.14	see drive keypad for information
272	delta_cnvdiag_faults.15	delta_cnvdiag_faults.15	see drive keypad for information
273	wye_cnvdiag_alarms.0	wye_cnvdiag_alarms.0	see drive keypad for information
274	wye_cnvdiag_alarms.1	wye_cnvdiag_alarms.1	see drive keypad for information
275	wye_cnvdiag_alarms.2	wye_cnvdiag_alarms.2	see drive keypad for information
276	wye_cnvdiag_alarms.3	wye_cnvdiag_alarms.3	see drive keypad for information
277	wye_cnvdiag_alarms.4	wye_cnvdiag_alarms.4	see drive keypad for information
278	wye_cnvdiag_alarms.5	wye_cnvdiag_alarms.5	see drive keypad for information
279	wye_cnvdiag_alarms.6	wye_cnvdiag_alarms.6	see drive keypad for information
280	wye_cnvdiag_alarms.7	wye_cnvdiag_alarms.7	see drive keypad for information
281	wye_cnvdiag_alarms.8	wye_cnvdiag_alarms.8	see drive keypad for information
282	wye_cnvdiag_alarms.9	wye_cnvdiag_alarms.9	see drive keypad for information
283	wye_cnvdiag_alarms.10	wye_cnvdiag_alarms.10	see drive keypad for information
284	wye_cnvdiag_alarms.11	wye_cnvdiag_alarms.11	see drive keypad for information
285	wye_cnvdiag_alarms.12	wye_cnvdiag_alarms.12	see drive keypad for information
286	wye_cnvdiag_alarms.13	wye_cnvdiag_alarms.13	see drive keypad for information
287	wye_cnvdiag_alarms.14	wye_cnvdiag_alarms.14	see drive keypad for information
288	wye_cnvdiag_alarms.15	wye_cnvdiag_alarms.15	see drive keypad for information
289	wye_cnvdiag_faults.0	wye_cnvdiag_faults.0	see drive keypad for information
290	wye_cnvdiag_faults.1	wye_cnvdiag_faults.1	see drive keypad for information

IP7011708

291	wye_cnvdiag_faults.2	wye_cnvdiag_faults.2	see drive keypad for information
292	wye_cnvdiag_faults.3	wye_cnvdiag_faults.3	see drive keypad for information
293	wye_cnvdiag_faults.4	wye_cnvdiag_faults.4	see drive keypad for information
294	wye_cnvdiag_faults.5	wye_cnvdiag_faults.5	see drive keypad for information
295	wye_cnvdiag_faults.6	wye_cnvdiag_faults.6	see drive keypad for information
296	wye_cnvdiag_faults.7	wye_cnvdiag_faults.7	see drive keypad for information
297	wye_cnvdiag_faults.8	wye_cnvdiag_faults.8	see drive keypad for information
298	wye_cnvdiag_faults.9	wye_cnvdiag_faults.9	see drive keypad for information
299	wye_cnvdiag_faults.10	wye_cnvdiag_faults.10	see drive keypad for information
300	wye_cnvdiag_faults.11	wye_cnvdiag_faults.11	see drive keypad for information
301	wye_cnvdiag_faults.12	wye_cnvdiag_faults.12	see drive keypad for information
302	wye_cnvdiag_faults.13	wye_cnvdiag_faults.13	see drive keypad for information
303	wye_cnvdiag_faults.14	wye_cnvdiag_faults.14	see drive keypad for information
304	wye_cnvdiag_faults.15	wye_cnvdiag_faults.15	see drive keypad for information
305	PCR Temp Alarm	temp_pcr>=tc3_alarm_level	PCR thermocouple measured temperature has exceeded the alarm level set on the HMI PCR temp page.
306	PCR Temp Trip	temp_pcr>=tc3_trip_level	PCR thermocouple measured temperature has exceeded the trip level set on the HMI PCR temp page.
307	TC Range Error	tc_range_error	The PLC thermocouple module has detected a under/over range error, a configuration or open circuit error to one of its inputs. Check HMI temperature feedback pages for further information on measured temperatures.
308	RTD Range Error	rtd_range_error	The RTD module has detected a under/over range error, a configuration, calibration or broken circuit error to one of its inputs. Check HMI temperature feedback pages for further information on measured temperatures.
309	D speed ref forced K115.0	spd_ref_frsd_delta	The remote speed reference is presently being forced by the commissioning error from CSP, this allows engineer to control speed when in remote mode as long as remote speed reference from boiler controls is below 5 %
310	Y speed ref forced K115.0	spd_ref_frsd_wye	The remote speed reference is presently being forced by the commissioning error from CSP, this allows engineer to control speed when in remote mode as long as remote speed reference from boiler controls is below 5 %
311	HMI_PLC Comms	CommsError>0	Communications between the HMI and the PLC has failed, check connections between PLC CPU DH485 connection and terminals at rear of HMI

IP7011709

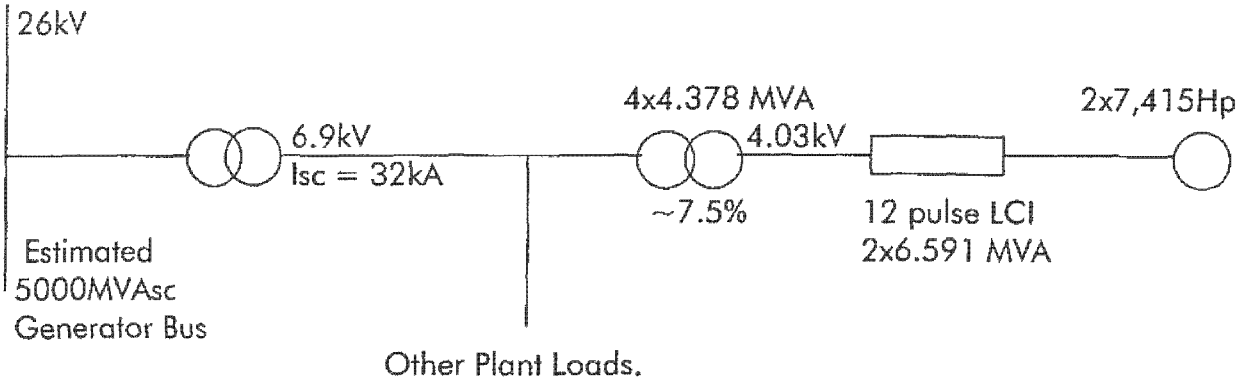
IP7011710

ALSTOM

Power Factor and Harmonic Review

A simple simulation model has been created to examine the steady state interaction of the proposed new LCI fan drive systems with the existing plant power system. By using a time domain simulation based on a detailed model of the ALSTOM LCI drive system it is possible to evaluate all system components in a truly interactive way.

The following simplified one-line diagram was produced considering the data supplied in the specification documents. Each boiler auxiliary power bus carries two identical 12 pulse LCI drive units that can be considered in isolation as each bus is supplied from a very high fault level system. The two drives are modeled together as one single, larger power 12 pulse drive system as when equally loaded, the worst case harmonic condition exists when the harmonic currents from the two drives add directly.



Simplified One Line Diagram Showing Data Provided

Simulation results from three operating conditions follow. These are: -

1. Two of the existing drives operating at full speed (954 rpm) and full load (7,415 Hp)
2. Two of the new drives operating at full speed (954 rpm) and full load (7,415 Hp) with optimization for improved power factor and harmonic distortion reduction
3. Two of the new drives operating at full speed (954 rpm) and the required higher load of 8,200Hp

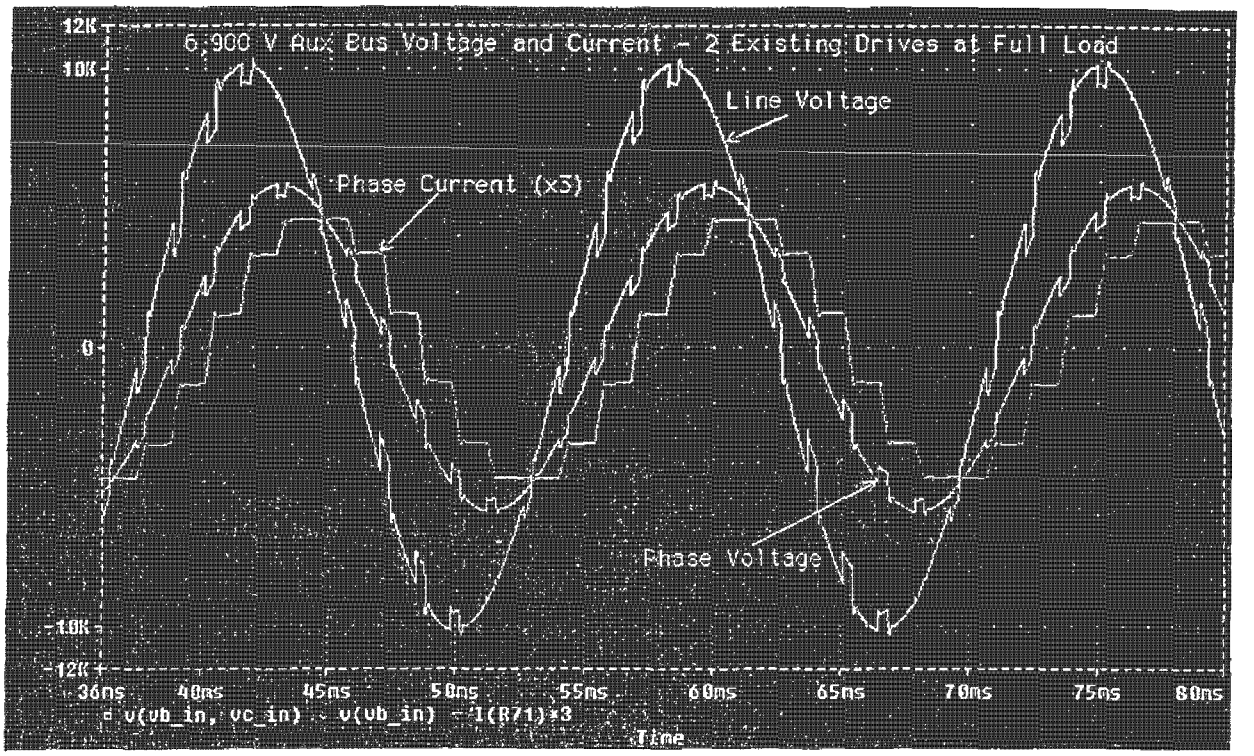
Operation at the future load point of 10,000 Hp at 1,050 rpm is discussed at the end of the review but this condition has not been simulated at this time. In order to operate above around 9,000 Hp the transformer and link choke will most likely need to be changed giving rise to a new simulation model.

© 2003 ALSTOM

IP7011711

Case 1: Two Existing Drive Units at Full Load (7,415 Hp @ 954 rpm)

In this case the bus loading is considered to be equivalent to two 12-pulse drive units both operating at 7,415 Hp and 954 rpm with exactly the same conduction angles such that the harmonic contributions from each drive unit add directly. The set up for the drives is as it might be for the older style of LCI drive unit where lots of voltage margin is maintained for power dips in the supply. The transformer secondary voltage is set for 4,031 Volts and the motor voltage is 3,876 Volts just as the original equipment was designed. The resultant 6,900 Volt bus voltage and current would look very like the following graphic insert taken from the simulation.



6,900 V Bus Current and Voltage Plot

Note that the current displayed in the above plot has been amplified by a factor of three. This was done so that the current waveform would be similar in size to the phase voltage plot so that a direct appreciation could be given for the power factor of the load on the bus. In this case the angular difference between the fundamental of the phase voltage and the phase current is 28.6° giving an apparent power factor of 0.878

The following tables of data represent the Fourier spectrum analysis of the line voltage and phase current. In this condition the voltage distortion is greater than 5% THD and the installation would not be IEEE 519 compliant if operated in this way.

© 2003 ALSTOM

The Fourier components of the line to line voltage and phase current are as follows: -

FOURIER COMPONENTS OF TRANSIENT RESPONSE V(Va_in,Vb_in) (Line to Line Voltage)

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	6.000E+01	1.000E+04	1.000E+00	-4.359E+01	0.000E+00
2	1.200E+02	1.786E+00	1.785E-04	1.735E+02	2.171E+02
3	1.800E+02	1.966E+01	1.966E-03	1.340E+02	1.776E+02
4	2.400E+02	6.266E-01	6.264E-05	-1.479E+02	-1.043E+02
5	3.000E+02	5.170E+00	5.168E-04	-1.583E+02	-1.147E+02
6	3.600E+02	6.404E-01	6.401E-05	-1.256E+01	3.103E+01
7	4.200E+02	5.625E+00	5.623E-04	-1.066E+02	-6.305E+01
8	4.800E+02	7.735E-01	7.732E-05	-1.664E+02	-1.228E+02
9	5.400E+02	1.938E+01	1.937E-03	-9.565E+01	-5.205E+01
10	6.000E+02	3.073E+00	3.072E-04	-1.485E+02	-1.049E+02
11	6.600E+02	3.165E+02	**3.164E-02**	-1.648E+02	-1.212E+02
12	7.200E+02	9.659E+00	9.656E-04	4.891E+01	9.250E+01
13	7.800E+02	2.854E+02	**2.853E-02**	5.731E+01	1.009E+02
14	8.400E+02	3.847E+00	3.846E-04	5.363E+01	9.723E+01
15	9.000E+02	1.138E+01	1.137E-03	6.384E+00	4.998E+01
16	9.600E+02	1.461E+00	1.460E-04	4.019E+01	8.379E+01
17	1.020E+03	7.055E+00	7.052E-04	9.346E+01	1.371E+02
18	1.080E+03	6.600E-01	6.598E-05	1.029E+02	1.465E+02
19	1.140E+03	6.502E+00	6.499E-04	1.443E+02	1.879E+02
20	1.200E+03	9.666E-01	9.662E-05	3.528E+01	7.887E+01
21	1.260E+03	5.272E+00	5.270E-04	1.166E+02	1.602E+02
22	1.320E+03	2.308E+00	2.308E-04	3.581E+01	7.941E+01
23	1.380E+03	2.341E+02	**2.340E-02**	5.246E+01	9.606E+01
24	1.440E+03	1.366E+00	1.366E-04	-4.068E+01	2.915E+00
25	1.500E+03	2.117E+02	**2.116E-02**	-9.098E+01	-4.738E+01
26	1.560E+03	4.253E+00	4.252E-04	8.297E+01	1.266E+02
27	1.620E+03	4.820E+00	4.818E-04	-6.412E+01	-2.052E+01
28	1.680E+03	9.072E-01	9.069E-05	-1.572E+02	-1.136E+02
29	1.740E+03	5.638E+00	5.636E-04	-1.679E+01	2.680E+01
30	1.800E+03	5.193E-01	5.191E-05	-2.069E+01	2.290E+01
31	1.860E+03	6.434E+00	6.432E-04	4.372E+01	8.732E+01
32	1.920E+03	5.680E-01	5.678E-05	9.821E+01	1.418E+02
33	1.980E+03	1.760E+01	1.760E-03	1.549E+02	1.985E+02
34	2.040E+03	6.849E-01	6.846E-05	1.514E+02	1.950E+02
35	2.100E+03	1.224E+02	**1.223E-02**	-8.870E+01	-4.511E+01
36	2.160E+03	4.039E+00	4.037E-04	3.756E+01	8.115E+01
37	2.220E+03	1.136E+02	**1.135E-02**	1.100E+02	1.536E+02
38	2.280E+03	1.950E+00	1.949E-04	-1.100E+02	-6.644E+01
39	2.340E+03	9.454E+00	9.451E-04	-1.528E+02	-1.092E+02
40	2.400E+03	1.859E+00	1.858E-04	-8.314E+01	-3.954E+01
41	2.460E+03	4.913E+00	4.911E-04	-1.026E+02	-5.905E+01
42	2.520E+03	8.087E-01	8.084E-05	1.769E+02	2.205E+02
43	2.580E+03	5.507E+00	5.505E-04	-5.526E+01	-1.166E+01
44	2.640E+03	1.030E+00	1.030E-04	-9.331E+01	-4.971E+01
45	2.700E+03	3.759E+01	3.758E-03	8.900E+00	5.249E+01
46	2.760E+03	5.930E-01	5.928E-05	-5.732E+01	-1.372E+01
47	2.820E+03	1.593E+01	**1.592E-03**	1.787E+02	2.223E+02
48	2.880E+03	3.953E+00	3.951E-04	-1.636E+02	-1.200E+02
49	2.940E+03	3.710E+01	**3.709E-03**	-1.121E+02	-6.853E+01
50	3.000E+03	3.329E+00	3.327E-04	8.041E+01	1.240E+02

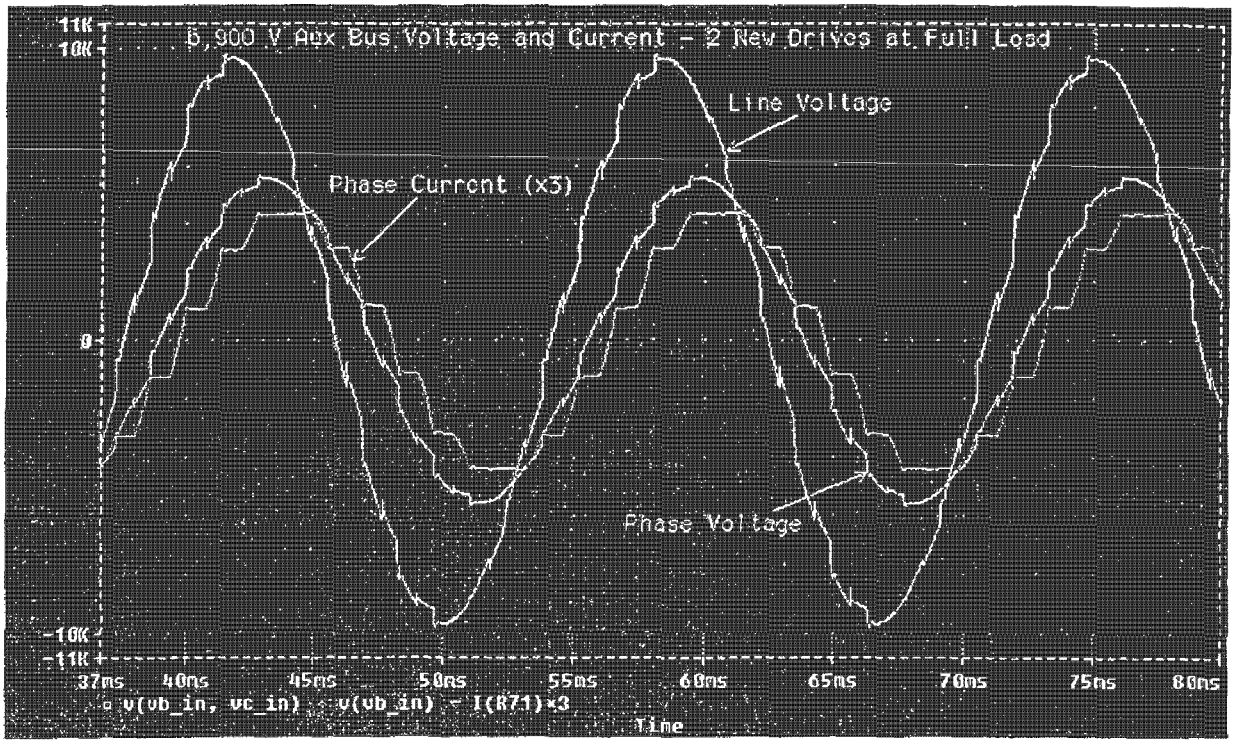
TOTAL HARMONIC DISTORTION = **5.60** PERCENT

© 2003 ALSTOM

IP7011713

Case 2: Two New Drive Units at Full Load (7,415 Hp @ 954 rpm)

In this case the bus loading is also considered to be equivalent to two 12-pulse drive units both operating at 7,415 Hp and 954 rpm again with exactly the same conduction angles. However, in this case the drives have been set up with very much less voltage margin, a condition made possible by modern control techniques giving rise to considerable improvements of power factor, harmonic distortion and efficiency. The transformer secondary voltage has been tapped down by 5% and the motor voltage has been raised by 5% so permitting the supply side rectifier to operate at a good conduction angle. The resultant 6,900 Volt bus voltage and current would look very like the following graphic insert taken from the simulation.



6,900 V Bus Current and Voltage Plot

Note that the current displayed in the above plot has again been amplified by a factor of three. In this case the angular difference between the fundamental of the phase voltage and the phase current is 15.5° giving an apparent power factor of 0.96

The following tables of data represent the Fourier spectrum analysis of the line voltage and phase current. In this condition the voltage distortion is less than 5% THD and the installation would be IEEE 519 compliant if operated in this way.

© 2003 ALSTOM

IP7011714

The Fourier components of the line to line voltage and phase current are as follows: -

FOURIER COMPONENTS OF TRANSIENT RESPONSE V(Va_in,Vb_in) (Line to Line Voltage)

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	6.000E+01	9.550E+03	1.000E+00	-4.384E+01	0.000E+00
2	1.200E+02	1.615E+00	1.691E-04	-9.635E+01	-5.251E+01
3	1.800E+02	9.898E+00	1.036E-03	1.259E+02	1.697E+02
4	2.400E+02	1.829E+00	1.915E-04	-1.669E+02	-1.231E+02
5	3.000E+02	1.750E+00	1.833E-04	1.542E+02	1.980E+02
6	3.600E+02	8.639E-01	9.045E-05	-1.397E+02	-9.590E+01
7	4.200E+02	3.356E+00	3.515E-04	1.705E+02	2.143E+02
8	4.800E+02	1.473E+00	1.542E-04	-1.065E+02	-6.264E+01
9	5.400E+02	6.106E-01	6.394E-05	-3.274E+01	1.110E+01
10	6.000E+02	4.006E+00	4.195E-04	-1.682E+02	-1.244E+02
11	6.600E+02	2.430E+02	**2.544E-02**	-2.194E+01	2.190E+01
12	7.200E+02	9.027E+00	9.452E-04	3.825E+01	8.209E+01
13	7.800E+02	2.216E+02	**2.321E-02**	-1.381E+02	-9.423E+01
14	8.400E+02	3.732E+00	3.908E-04	7.074E+01	1.146E+02
15	9.000E+02	2.867E+00	3.002E-04	9.015E+01	1.340E+02
16	9.600E+02	1.645E+00	1.722E-04	9.206E+01	1.359E+02
17	1.020E+03	1.861E+00	1.948E-04	-1.241E+02	-8.031E+01
18	1.080E+03	1.156E+00	1.210E-04	6.612E+01	1.100E+02
19	1.140E+03	1.260E+00	1.319E-04	-1.114E+02	-6.757E+01
20	1.200E+03	4.300E-01	4.502E-05	-1.386E+02	-9.480E+01
21	1.260E+03	1.243E+01	1.302E-03	-7.272E+01	-2.889E+01
22	1.320E+03	3.340E+00	3.498E-04	1.039E+02	1.477E+02
23	1.380E+03	6.243E+01	**6.537E-03**	-3.642E+01	7.413E+00
24	1.440E+03	6.141E+00	6.430E-04	8.444E-01	4.468E+01
25	1.500E+03	5.587E+01	**5.850E-03**	-1.701E+02	-1.262E+02
26	1.560E+03	2.891E+00	3.027E-04	1.460E+02	1.898E+02
27	1.620E+03	6.233E+00	6.527E-04	-3.875E+01	5.090E+00
28	1.680E+03	7.446E-01	7.796E-05	9.263E+01	1.365E+02
29	1.740E+03	1.278E+00	1.338E-04	-4.972E+01	-5.882E+00
30	1.800E+03	4.023E-01	4.213E-05	9.361E+01	1.375E+02
31	1.860E+03	2.576E+00	2.697E-04	2.286E+01	6.669E+01
32	1.920E+03	1.088E+00	1.140E-04	1.712E+02	2.150E+02
33	1.980E+03	5.938E+00	6.217E-04	-8.443E+01	-4.059E+01
34	2.040E+03	3.502E+00	3.667E-04	5.758E+01	1.014E+02
35	2.100E+03	7.037E+01	**7.368E-03**	-1.407E+02	-9.689E+01
36	2.160E+03	3.590E+00	3.759E-04	-7.231E+01	-2.847E+01
37	2.220E+03	8.437E+01	**8.835E-03**	9.914E+01	1.430E+02
38	2.280E+03	3.162E+00	3.311E-04	1.545E+02	1.984E+02
39	2.340E+03	4.971E+00	5.205E-04	7.057E+01	1.144E+02
40	2.400E+03	1.543E+00	1.615E-04	-4.805E+01	-4.214E+00
41	2.460E+03	1.999E+00	2.093E-04	1.013E+02	1.452E+02
42	2.520E+03	8.351E-01	8.744E-05	-7.465E+01	-3.082E+01
43	2.580E+03	2.611E+00	2.734E-04	8.182E+01	1.257E+02
44	2.640E+03	1.052E+00	1.102E-04	1.283E+02	1.722E+02
45	2.700E+03	1.787E+01	1.871E-03	1.533E+02	1.971E+02
46	2.760E+03	3.652E+00	3.824E-04	-5.810E+00	3.803E+01
47	2.820E+03	3.473E+01	**3.636E-03**	-1.668E+02	-1.230E+02
48	2.880E+03	4.607E+00	4.824E-04	-1.347E+02	-9.088E+01
49	2.940E+03	3.949E+01	**4.135E-03**	7.097E+01	1.148E+02
50	3.000E+03	3.625E+00	3.796E-04	8.589E+01	1.297E+02

TOTAL HARMONIC DISTORTION = 3.79 PERCENT

© 2003 ALSTOM

IP7011715

FOURIER COMPONENTS OF TRANSIENT RESPONSE I(R_R71) (Line Current)

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	6.000E+01	1.487E+03	1.000E+00	1.507E+02	0.000E+00
2	1.200E+02	2.201E+00	1.480E-03	1.321E+02	-1.859E+01
3	1.800E+02	9.280E-01	6.239E-04	1.173E+02	-3.334E+01
4	2.400E+02	6.767E-01	4.550E-04	1.354E+02	-1.526E+01
5	3.000E+02	5.934E-01	3.989E-04	1.544E+02	3.721E+00
6	3.600E+02	3.653E-01	2.456E-04	1.555E+02	4.806E+00
7	4.200E+02	5.592E-01	3.759E-04	1.379E+02	-1.280E+01
8	4.800E+02	5.494E-01	3.694E-04	1.181E+02	-3.260E+01
9	5.400E+02	5.539E-01	3.724E-04	1.175E+02	-3.320E+01
10	6.000E+02	8.689E-01	5.842E-04	8.400E+01	-6.668E+01
11	6.600E+02	1.037E+02	**6.974E-02**	-1.407E+02	-2.914E+02
12	7.200E+02	3.038E+00	2.042E-03	-8.156E+01	-2.322E+02
13	7.800E+02	7.803E+01	**5.246E-02**	1.627E+02	1.198E+01
14	8.400E+02	1.260E+00	8.471E-04	-1.258E+01	-1.633E+02
15	9.000E+02	3.209E-01	2.157E-04	-4.694E+01	-1.976E+02
16	9.600E+02	3.156E-01	2.122E-04	-7.510E+01	-2.258E+02
17	1.020E+03	2.065E-01	1.388E-04	-9.069E+01	-2.414E+02
18	1.080E+03	3.244E-01	2.181E-04	-7.982E+01	-2.305E+02
19	1.140E+03	1.949E-01	1.310E-04	-6.468E+01	-2.154E+02
20	1.200E+03	2.778E-01	1.868E-04	-6.990E+01	-2.206E+02
21	1.260E+03	6.166E-01	4.146E-04	-2.969E+01	-1.804E+02
22	1.320E+03	3.761E-01	2.529E-04	-4.925E+01	-1.999E+02
23	1.380E+03	1.532E+01	**1.030E-02**	-1.484E+02	-2.991E+02
24	1.440E+03	9.240E-01	6.212E-04	-1.089E+02	-2.596E+02
25	1.500E+03	1.032E+01	**6.939E-03**	1.366E+02	-1.412E+01
26	1.560E+03	2.975E-01	2.000E-04	7.148E+01	-7.920E+01
27	1.620E+03	5.799E-01	3.899E-04	-1.687E+02	-3.193E+02
28	1.680E+03	2.430E-01	1.634E-04	-1.595E+02	-3.101E+02
29	1.740E+03	2.170E-01	1.459E-04	-1.705E+02	-3.212E+02
30	1.800E+03	1.767E-01	1.188E-04	-1.622E+02	-3.129E+02
31	1.860E+03	9.259E-02	6.225E-05	-1.593E+02	-3.099E+02
32	1.920E+03	1.899E-01	1.277E-04	-1.087E+02	-2.593E+02
33	1.980E+03	1.960E-01	1.318E-04	-6.851E+01	-2.192E+02
34	2.040E+03	2.795E-01	1.879E-04	-1.128E+02	-2.635E+02
35	2.100E+03	9.200E+00	**6.185E-03**	1.064E+02	-4.432E+01
36	2.160E+03	4.079E-01	2.742E-04	-1.694E+02	-3.201E+02
37	2.220E+03	9.295E+00	**6.249E-03**	3.761E+01	-1.131E+02
38	2.280E+03	4.123E-01	2.772E-04	1.024E+02	-4.829E+01
39	2.340E+03	4.991E-01	3.356E-04	4.095E+01	-1.097E+02
40	2.400E+03	2.318E-01	1.558E-04	-1.699E+02	-3.205E+02
41	2.460E+03	1.178E-01	7.921E-05	-1.582E+02	-3.089E+02
42	2.520E+03	1.569E-01	1.055E-04	1.749E+02	2.423E+01
43	2.580E+03	1.542E-01	1.037E-04	-1.497E+02	-3.004E+02
44	2.640E+03	1.750E-01	1.177E-04	-1.625E+02	-3.132E+02
45	2.700E+03	8.880E-01	5.970E-04	-1.470E+02	-2.977E+02
46	2.760E+03	2.159E-01	1.452E-04	-1.634E+02	-3.141E+02
47	2.820E+03	5.660E+00	**3.805E-03**	9.335E+01	-5.733E+01
48	2.880E+03	2.375E-01	1.597E-04	1.309E+02	-1.983E+01
49	2.940E+03	3.870E+00	**2.602E-03**	1.763E+01	-1.331E+02
50	3.000E+03	2.739E-01	1.841E-04	-1.816E+01	-1.688E+02

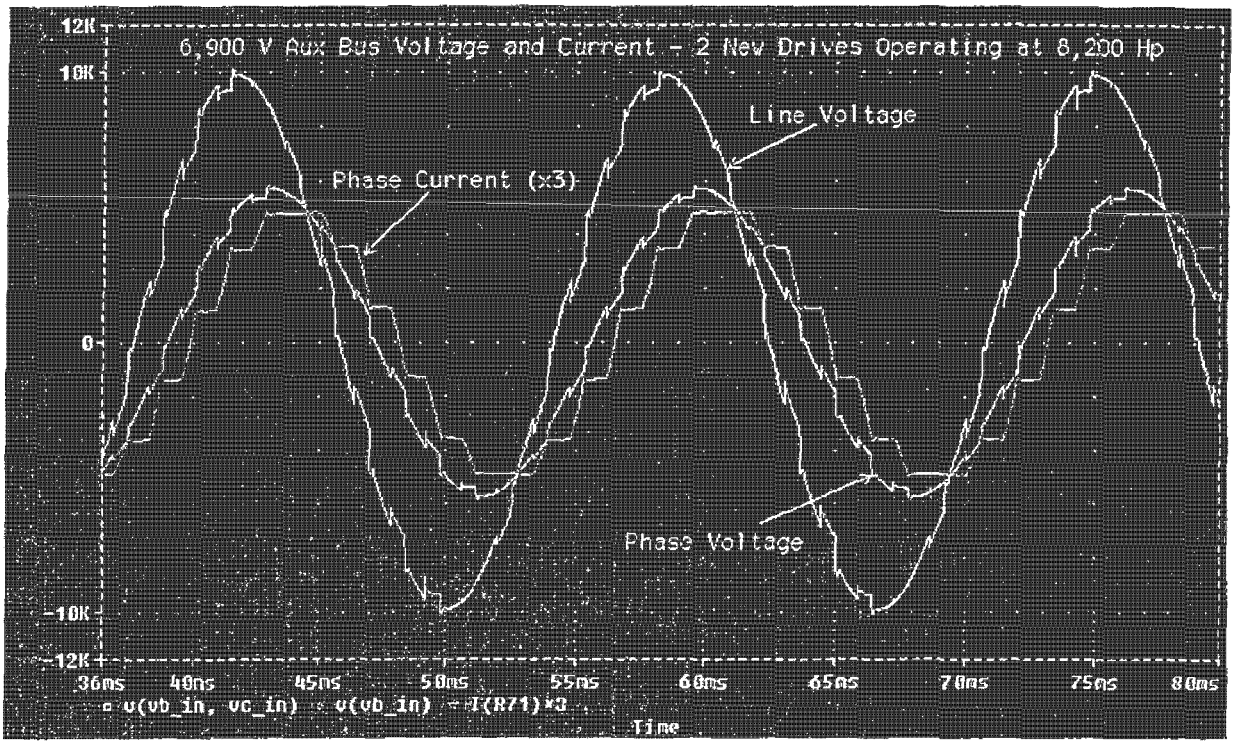
TOTAL HARMONIC DISTORTION = 8.88 PERCENT

© 2003 ALSTOM

IP7011716

Case 3: Two New Drive Units at the Future Load (8,200 Hp @ 954 rpm)

In this case the bus loading is again considered to be equivalent to two 12-pulse drive units but in this case both operating at 8,200 Hp and 954 rpm again with exactly the same conduction angles. Once again the operating conditions have been optimized to permit the drives to operate with a good conduction angle. In this case the transformer secondary voltage has been tapped down by 2.5% and the motor voltage has been raised by 5%. The resultant 6,900 Volt bus voltage and current would look very like the following graphic insert taken from the simulation.



6,900 V Bus Current and Voltage Plot

Note that the current displayed in the above plot has again been amplified by a factor of three. In this case the angular difference between the fundamental of the phase voltage and the phase current is 18.3° giving an apparent power factor of 0.95

The following tables of data represent the Fourier spectrum analysis of the line voltage and phase current. In this condition the voltage distortion is less than 5% THD and the installation would be at the limit of IEEE 519 compliance if operated in this way.

© 2003 ALSTOM

The Fourier components of the line to line voltage and phase current are as follows: -

FOURIER COMPONENTS OF TRANSIENT RESPONSE V(Va_in,Vb_in) (Line to Line Voltage)

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	6.000E+01	9.773E+03	1.000E+00	-4.391E+01	0.000E+00
2	1.200E+02	4.066E+00	4.161E-04	1.649E+02	2.088E+02
3	1.800E+02	6.878E+00	7.038E-04	1.165E+02	1.604E+02
4	2.400E+02	2.136E+00	2.185E-04	-1.099E+02	-6.601E+01
5	3.000E+02	4.584E+00	4.691E-04	-9.486E+01	-5.095E+01
6	3.600E+02	2.533E+00	2.592E-04	-8.094E+01	-3.703E+01
7	4.200E+02	1.621E+00	1.658E-04	-3.698E+01	6.930E+00
8	4.800E+02	1.736E+00	1.777E-04	2.661E+01	7.052E+01
9	5.400E+02	1.282E+01	1.312E-03	4.926E+01	9.317E+01
10	6.000E+02	5.691E-01	5.823E-05	7.538E+01	1.193E+02
11	6.600E+02	2.993E+02	**3.062E-02**	-5.325E+01	-9.334E+00
12	7.200E+02	5.022E+00	5.139E-04	5.912E+01	1.030E+02
13	7.800E+02	2.507E+02	**2.565E-02**	-1.762E+02	-1.323E+02
14	8.400E+02	3.490E+00	3.571E-04	9.253E+01	1.364E+02
15	9.000E+02	5.895E+00	6.032E-04	-7.029E+01	-2.638E+01
16	9.600E+02	2.802E+00	2.867E-04	-5.500E+01	-1.109E+01
17	1.020E+03	2.867E+00	2.933E-04	-5.430E+01	-1.039E+01
18	1.080E+03	2.079E+00	2.127E-04	5.971E+00	4.988E+01
19	1.140E+03	5.218E+00	5.339E-04	4.332E+01	8.723E+01
20	1.200E+03	3.815E+00	3.903E-04	3.644E+01	8.036E+01
21	1.260E+03	2.467E+00	2.524E-04	-2.432E+01	1.960E+01
22	1.320E+03	1.864E+00	1.908E-04	1.265E+02	1.704E+02
23	1.380E+03	1.082E+02	**1.108E-02**	-8.856E+01	-4.465E+01
24	1.440E+03	2.330E+00	2.384E-04	-1.113E+01	3.278E+01
25	1.500E+03	7.945E+01	**8.129E-03**	1.407E+02	1.847E+02
26	1.560E+03	1.148E+00	1.174E-04	3.840E+01	8.231E+01
27	1.620E+03	1.170E+01	1.197E-03	-1.093E+02	-6.540E+01
28	1.680E+03	1.393E+00	1.425E-04	-7.441E+01	-3.050E+01
29	1.740E+03	2.488E+00	2.546E-04	4.107E+01	8.498E+01
30	1.800E+03	2.340E+00	2.395E-04	6.841E+01	1.123E+02
31	1.860E+03	2.527E+00	2.586E-04	7.436E+01	1.183E+02
32	1.920E+03	1.159E+00	1.186E-04	1.609E+02	2.048E+02
33	1.980E+03	1.958E+01	2.004E-03	-1.611E+02	-1.172E+02
34	2.040E+03	2.924E+00	2.992E-04	1.652E+02	2.091E+02
35	2.100E+03	7.919E+01	**8.103E-03**	1.154E+02	1.593E+02
36	2.160E+03	1.911E+00	1.956E-04	-1.120E+02	-6.805E+01
37	2.220E+03	7.395E+01	**7.567E-03**	-4.717E+00	3.919E+01
38	2.280E+03	1.997E+00	2.044E-04	-3.681E+01	7.101E+00
39	2.340E+03	4.444E+00	4.547E-04	7.505E+01	1.190E+02
40	2.400E+03	1.451E+00	1.485E-04	2.865E+01	7.256E+01
41	2.460E+03	3.438E+00	3.518E-04	4.633E+01	9.024E+01
42	2.520E+03	1.567E+00	1.603E-04	7.712E+01	1.210E+02
43	2.580E+03	3.751E+00	3.838E-04	-1.793E+02	-1.354E+02
44	2.640E+03	3.674E+00	3.760E-04	-1.794E+02	-1.355E+02
45	2.700E+03	1.523E+01	1.558E-03	1.606E+02	2.045E+02
46	2.760E+03	1.558E+00	1.594E-04	-8.228E+01	-3.837E+01
47	2.820E+03	9.405E+01	**9.623E-03**	6.463E+01	1.085E+02
48	2.880E+03	1.692E+00	1.731E-04	-2.541E+01	1.850E+01
49	2.940E+03	6.766E+01	**6.924E-03**	-5.776E+01	-1.384E+01
50	3.000E+03	4.578E-02	4.685E-06	1.557E+01	5.948E+01

TOTAL HARMONIC DISTORTION = **4.54** PERCENT

© 2003 ALSTOM

IP7011718

FOURIER COMPONENTS OF TRANSIENT RESPONSE I(R_R71) (Line Current)

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	6.000E+01	1.650E+03	1.000E+00	1.478E+02	0.000E+00
2	1.200E+02	2.083E+00	1.263E-03	1.303E+02	-1.750E+01
3	1.800E+02	8.739E-01	5.298E-04	1.245E+02	-2.330E+01
4	2.400E+02	5.983E-01	3.627E-04	1.355E+02	-1.233E+01
5	3.000E+02	4.661E-01	2.826E-04	1.568E+02	8.996E+00
6	3.600E+02	4.022E-01	2.438E-04	1.382E+02	-9.604E+00
7	4.200E+02	3.404E-01	2.064E-04	1.326E+02	-1.524E+01
8	4.800E+02	3.671E-01	2.225E-04	1.168E+02	-3.097E+01
9	5.400E+02	7.907E-01	4.794E-04	1.102E+02	-3.763E+01
10	6.000E+02	2.893E-01	1.754E-04	7.335E+01	-7.445E+01
11	6.600E+02	1.207E+02	**7.314E-02**	-1.719E+02	-3.197E+02
12	7.200E+02	2.860E+00	1.734E-03	-8.876E+01	-2.366E+02
13	7.800E+02	9.092E+01	**5.512E-02**	1.257E+02	-2.207E+01
14	8.400E+02	8.396E-01	5.090E-04	-6.283E+00	-1.541E+02
15	9.000E+02	3.927E-01	2.381E-04	-9.016E+01	-2.380E+02
16	9.600E+02	2.459E-01	1.491E-04	-7.386E+01	-2.217E+02
17	1.020E+03	2.862E-01	1.735E-04	-8.436E+01	-2.322E+02
18	1.080E+03	1.902E-01	1.153E-04	-8.720E+01	-2.350E+02
19	1.140E+03	2.269E-01	1.376E-04	-8.466E+01	-2.325E+02
20	1.200E+03	2.350E-01	1.425E-04	-8.173E+01	-2.295E+02
21	1.260E+03	2.189E-01	1.327E-04	-8.512E+01	-2.329E+02
22	1.320E+03	4.856E-01	2.944E-04	-8.972E+01	-2.375E+02
23	1.380E+03	2.148E+01	**1.302E-02**	1.549E+02	7.118E+00
24	1.440E+03	8.976E-01	5.441E-04	-1.278E+02	-2.756E+02
25	1.500E+03	1.541E+01	**9.341E-03**	8.367E+01	-6.412E+01
26	1.560E+03	6.191E-01	3.753E-04	2.236E+01	-1.254E+02
27	1.620E+03	6.891E-01	4.178E-04	1.657E+02	1.794E+01
28	1.680E+03	2.199E-01	1.333E-04	1.606E+02	1.276E+01
29	1.740E+03	1.219E-01	7.387E-05	1.616E+02	1.376E+01
30	1.800E+03	1.046E-01	6.339E-05	1.700E+02	2.216E+01
31	1.860E+03	1.453E-01	8.807E-05	1.696E+02	2.182E+01
32	1.920E+03	1.323E-01	8.017E-05	-1.692E+02	-3.170E+02
33	1.980E+03	6.902E-01	4.184E-04	-1.198E+02	-2.676E+02
34	2.040E+03	2.070E-01	1.255E-04	1.664E+02	1.861E+01
35	2.100E+03	7.501E+00	**4.547E-03**	4.778E+00	-1.430E+02
36	2.160E+03	3.000E-01	1.819E-04	8.004E+01	-6.776E+01
37	2.220E+03	9.480E+00	**5.747E-03**	-6.669E+01	-2.145E+02
38	2.280E+03	2.787E-01	1.690E-04	2.882E+01	-1.190E+02
39	2.340E+03	5.568E-01	3.375E-04	1.620E+01	-1.316E+02
40	2.400E+03	1.456E-01	8.829E-05	1.521E+02	4.335E+00
41	2.460E+03	7.646E-02	4.635E-05	1.067E+02	-4.114E+01
42	2.520E+03	4.693E-02	2.845E-05	1.537E+02	5.886E+00
43	2.580E+03	6.752E-02	4.093E-05	1.543E+02	6.540E+00
44	2.640E+03	9.864E-02	5.980E-05	1.522E+02	4.426E+00
45	2.700E+03	5.738E-01	3.478E-04	-1.449E+02	-2.927E+02
46	2.760E+03	1.958E-01	1.187E-04	8.399E+01	-6.381E+01
47	2.820E+03	7.393E+00	**4.482E-03**	-4.749E+01	-1.953E+02
48	2.880E+03	2.536E-01	1.537E-04	-1.594E+01	-1.637E+02
49	2.940E+03	6.624E+00	**4.015E-03**	-1.133E+02	-2.611E+02
50	3.000E+03	5.223E-02	3.166E-05	-6.634E+01	-2.141E+02

TOTAL HARMONIC DISTORTION = **9.35** PERCENT

© 2003 ALSTOM

IP7011719

Summary of Findings

IEEE Standard 519-1992 "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems" provides recommended practices for Utilities within Chapter 11. The recommended practices are based on voltage distortion limits as stated in Table 11.1 on page 85 and repeated here below for reference.

Bus Voltage at PCC	Individual Voltage Distortion (%)	Total Voltage Distortion THD (%)
69 kV and below	3.0	5.0
69,001 V through 161 kV	1.5	2.5
161,001 V and above	1.0	1.5

Voltage Distortion Limits per IEEE 519 Table 11.1

Current distortion limits are also provided in Chapter 10 of the standard as a way to distinguish individual user contributions to a possible voltage distortion problem. The current distortion limitations are not applicable in this case where the design goals for the correct application of the LCI equipment are:

- To ensure that the supply voltage available to the consumer is substantially free of harmonic distortion.
- To ensure that other plant equipment is relatively unaffected by the addition of the LCI drive units.

Both of these design goals can be achieved by following the guideline for voltage distortion outlined in Table 11.1

Voltage Distortion at the 6.9 kV Bus

Due to the extremely high fault levels at the primary of the 6.9 kV Bus feeder transformers, each 6.9 kV Bus can be considered practically in isolation. Very little harmonic distortion from the other LCI drive units on the other busses will be seen reflected at the 6.9 kV level.

Other power equipment connected to the 6.9 kV Bus (motors) will tend to help to reduce the distortion levels and because the THD is not more than 5% in the worst case (steady state) will operate relatively unaffected by the harmonic distortion.

Voltage Distortion at the Plant Distribution Level

An estimate of the worst case total voltage distortion at the plant distribution level can be made for each plant based on the estimated fault level for the generator bus (5,000 MVA). A mathematical addition of the contribution of 8 drive units can be made in order to assess this. Due to the estimation of the system fault level some degree of error may exist but the calculated levels are less than 1.5% THD and less than 1% at any single harmonic frequency. IEEE 519 compliance is therefore confirmed.

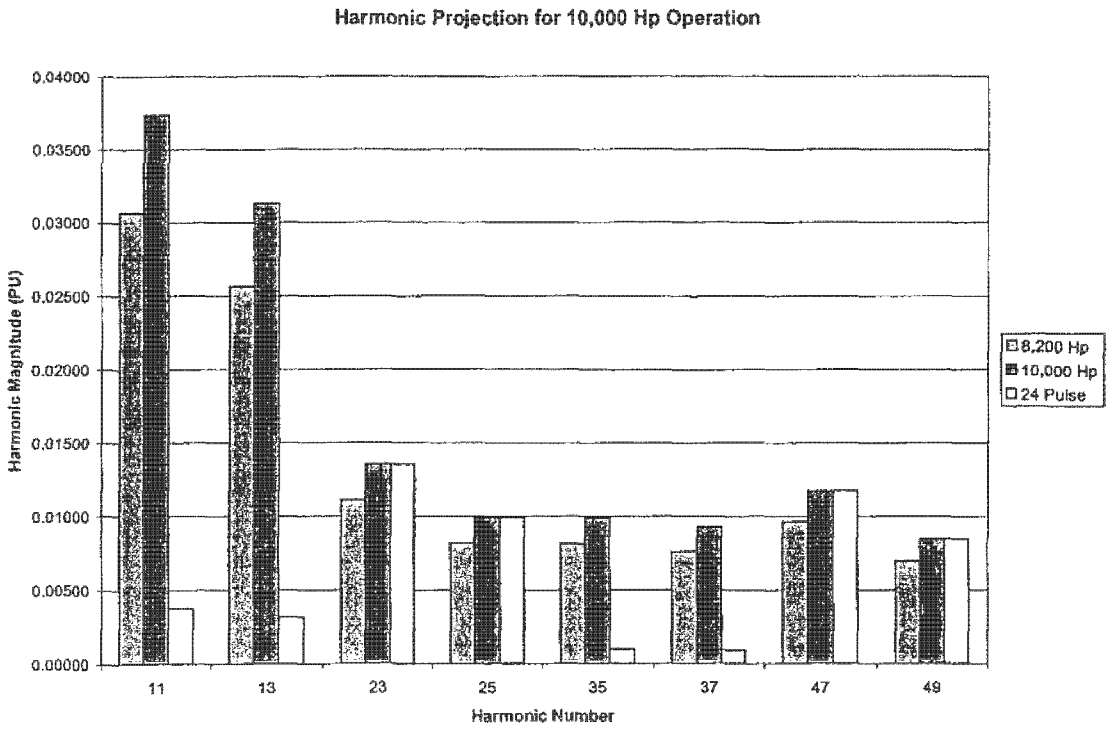
© 2003 ALSTOM

Future Operation at 10,000 Hp

At some time in the future it is proposed to operate each fan to a possible maximum load of 10,000 Hp and speed of 1,050 rpm. Operation of the existing motors with the new LCI drives at the new power and speed level will require close examination by the motor manufacturer but is certainly not out of the question. A number of possible options for this exist.

From the preceding review of the harmonic levels generated by the new drive equipment when operated at 7,415 HP or 8,200 Hp it can be seen that, from a purely harmonic distortion point of view, operation at 10,000 Hp will create excessive distortion.

Looking to the other components of the system it is also apparent that the choke and transformer may have to be changed in order to sustain the future, higher power levels. This gives rise to the possibility of replacing the existing transformers with transformers that provide 24-pulse harmonic cancellation. This can be readily achieved by arranging for each pair of drives on each auxiliary bus to be fed by a 12-pulse transformer that has a +/-7.5° primary phase shift. This technique has been successfully employed at other boilers and will greatly reduce the overall harmonic load by virtue of the additional harmonic cancellation that this provides. Harmonic levels will be reduced to levels below those projected for the new drives operating in 12-pulse mode as illustrated below. THD will be reduced to around 3% by this means.



Power Factor Correction

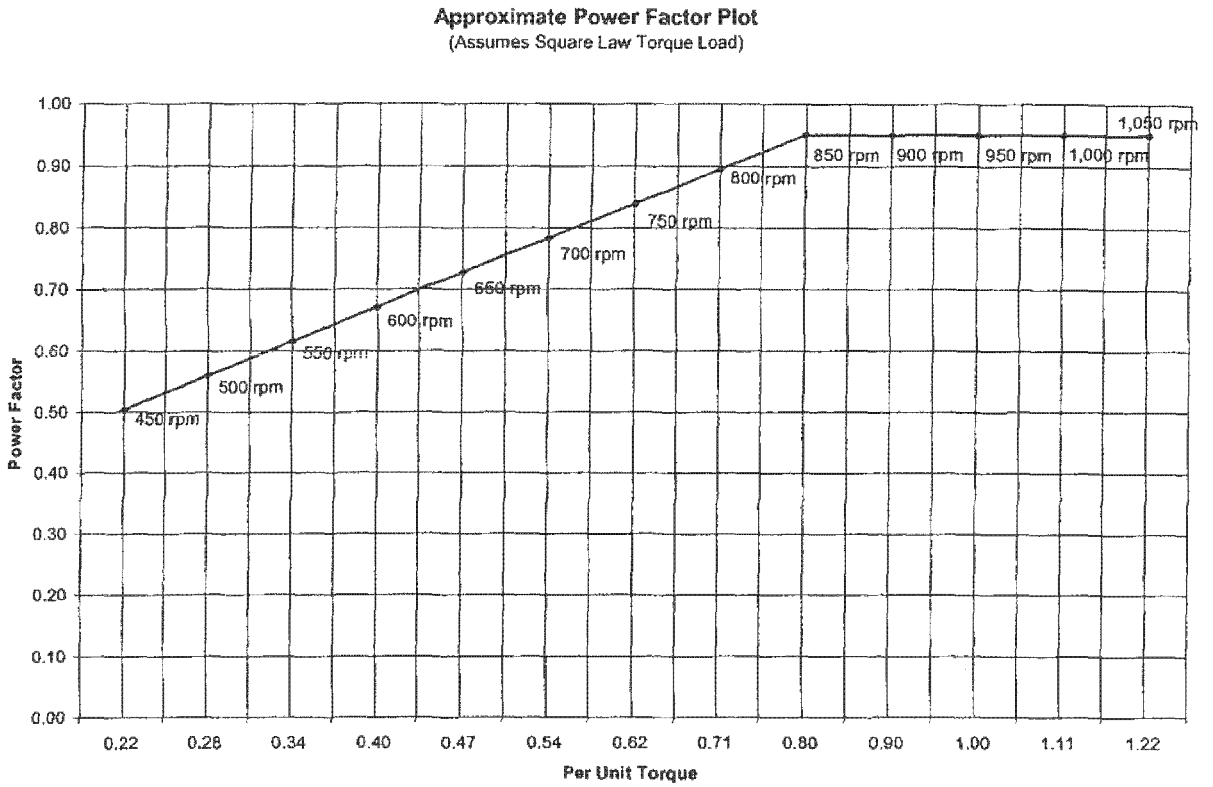
The following graph illustrates the typical LCI drive power factor characteristic as would be applicable to this application at nominal supply voltage levels and with the optimization discussed in the earlier sections employed. The best sustainable power factor is approximately that of a

© 2003 ALSTOM

IP7011721

diode bridge (~0.95 lag) due to operation at near free firing conditions for the thyristor rectifier front end of the LCI drive system.

Below 850 rpm the LCI power factor will reduce in an approximately linear fashion, as shown due to the phasing back of the supply side rectifier and the reduction of the motor voltage with speed. This is the characteristic of a current source drive system.

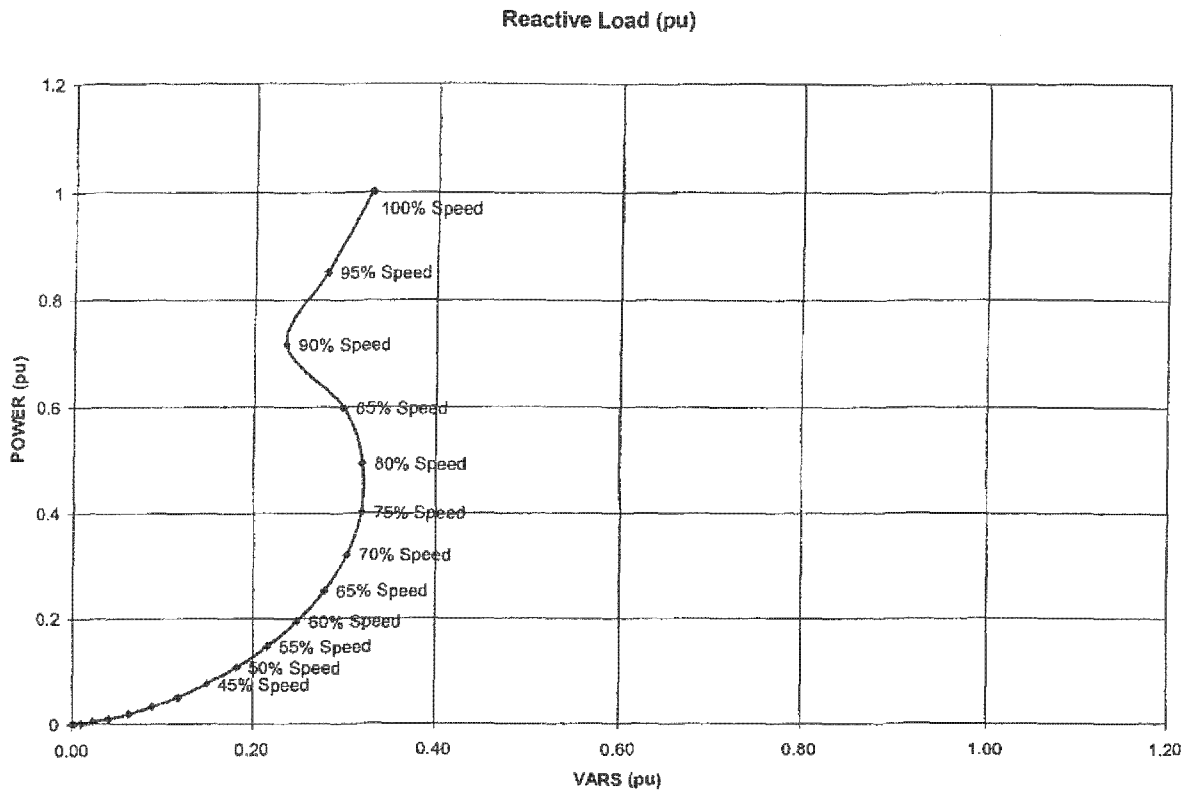


In the consideration of power factor correction the following illustration is very important as this shows how the reactive power consumption of the drive system varies with operating power levels and speed when operated with a square law torque load profile. It is important to note that the VARs consumed by the drive are at the maximum value when the drive is operated at full load, full speed. Even though the power factor of the drive does reduce steadily at lower speeds the reactive power consumption remains less than that at full speed.

When sizing correction equipment for power factor the amount of VARs consumed by the load is the important factor and in this case it can be seen that each drive will require approximately 35% of its rating in VARs leading to bring the power factor to unity.

© 2003 ALSTOM

IP7011722



At speeds greater than 100% the VARs consumed will increase in a linear manner up to that value to be expected at the projected 10,000 Hp level which would be around 44% of each drives' rating in VARs.

In the considerotion of power factor correction it is also important to consider all busloads in order to effect system wide correction and not just drive correction.

© 2003 ALSTOM

ALSTOM

Quality Procedure

Home Up Print Quality Versi

Number	Title	ISO 9001:2000 Equivalent	Date	Revi
---	Title Page			
QMTOC	Table of Contents			
QP40000	Quality Assurance Program	4.1 - 4.22	June 27, 2003	4
QP40110	Quality Policy Statement	5.3	July 12, 2000	2
QP40120	Management Responsibility	5.1, 5.2, 5.4.1, 5.5, 5.5.3, 5.6, 6.1, 8.2.1, 8.4, 8.5.1	August 14, 2003	1
QP40300	Bid and Order Review Process	7.2, 7.2.3	August 15, 2003	1
QP40330	Contract Scope Change		August 15, 2003	7
QP40400	Project Management & Design Control	5.4.2, 7.3	August 15, 2003	1
QP40500	Document & Data Control	4.2.3	July 21, 2003	8
QP40600	Purchasing	7.4	July 1, 2003	1
QP40700	Control of Customer-Supplied Product	7.5.4	June 30, 2003	4
QP40800	Product Identification & Traceability	7.5.3	July 18, 2003	8
QP40900	Process Control	6.3, 6.4, 7.1, 7.5.1	July 1, 2003	7
QP41000	Inspection and Testing	8.2.4	July 15, 2003	1
QP41100	Control of Inspection, Measuring, and Test Equipment	7.6	August 15, 2003	1
QP41200	Inspection and Test Status		August 15, 2003	4
QP41300	Control of Nonconforming Product	8.3	June 19, 2003	1
QP41400	Corrective and Preventive Action	8.5.2, 8.5.3	July 21, 2003	9
QP41500	Handling, Storage, Packaging, Preservation & Delivery		August 15, 2003	9
QP41600	Control of Quality Records	4.2.4	August 15, 2003	6

QP41700	Internal Quality Audits	8.2.2	July 21, 2003	5
QP41800	Training	6.2.2	July 21, 2003	3
QP41900	Customer Service Inquiry Procedure	7.5.1	June 19, 2003	1
QP41901	Warranty Procedure		July 8, 2003	8
QP41902	Customer Complaint Procedure		May 21, 2003	1
QP42000	Statistical Techniques		August 15, 2003	5
QP42100	Urgent Release of Product to Field		August 15, 2003	7
	All Procedures	8.2.3		
---	**Appendix 1 - Quality Forms**			
QF40000	Quality Document Approval Form		July 26, 2000	E
QF40502	Example of Procedure Format		July 12, 2000	E
QF40503	Example of Work Instruction Format		July 12, 2000	E
QF40610	Supplier / Subcontractor Quality Assessment		July 26, 2000	E
QF40800	Serial Number Record Sheet		October 3, 2002	E
QF41300	Nonconformity Report (NCR)		May 30, 2000	F
QF41400	Quality Action Request		July 26, 2000	E
QF41700	Quality System Audit Schedule		January 22, 2001	E
QF41800	Internal/External Training Form		March 16, 2001	E
QF41802	Qualification Form		July 26, 2000	E
QF41902	Customer Complaint		May 4, 2000	E

Title:	**CAD Standards**
Number:	**EW40502**
Revision:	**E**
Date:	**March 10, 2000**

Changed in this Revision:	1. – 7.

1. FILE STRUCTURING

Drawings are to be filed under the specific contract by Job Number and as set forth by the following pages:

Figure A - Project File Structure
Figure B - Tenders File Structure
Figure C - Misc File Structure
Figure D - Numbering System
Figure E - Block Procedure

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011726

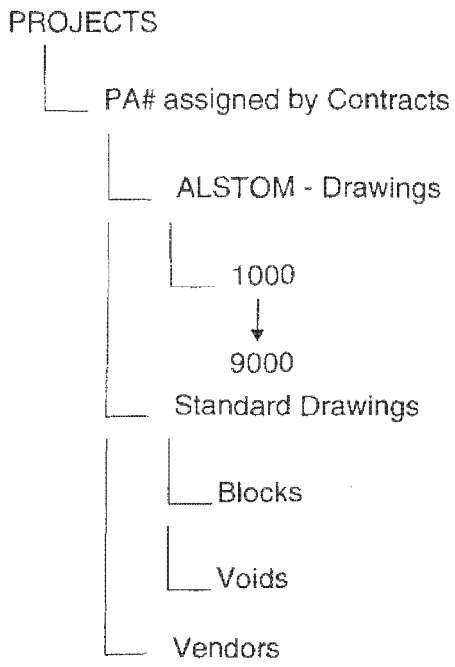


FIGURE A - PROJECT FILE STRUCTURE

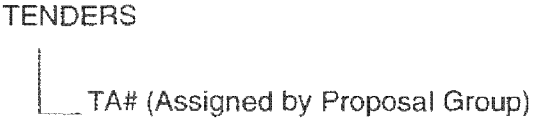


FIGURE B - TENDERS FILE STRUCTURE

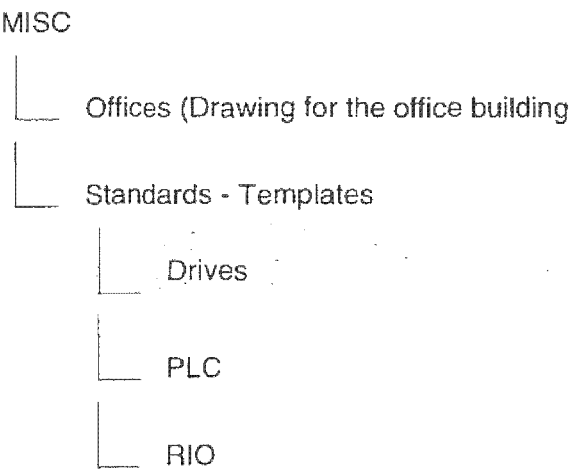


FIGURE C - MISCELLANEOUS FILE STRUCTURE

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011727

FIGURE D - NUMBERING SYSTEM

	Starting No.	Finishing No.	List of Apparatus
1	1000	1999	Power Distribution and Single Lines
	1000	1009	13.8 kV Single Lines
	1010	1019	480V Unit Sub Single Lines
	1020	1029	Motor Control Center Single Lines
	1030	1039	Drive Single Lines
	1040	1049	Rectifier Single Lines
2	1100	1499	120V/240V Distribution
3	1500	1999	UPS Distribution
4	2000	3000	Drive Schematics
5	3000		Automation/Network System Configurations
6	3100	3110	PLC Gas and Schematics
7	3200	3400	Operation Stations GAs and Schematics
8	4000	4010	Control Desk GAs and Schematics
9	4100	4200	Remote I/O GAs and Schematics
10	5000	5010	Pre-Fabricated Control Rooms
11	5100	5105	Pulpits
12	5200	5250	E-Stop Relays Panels GAs and Schematics
13	5300	5399	Air and Ventilation Systems
14	5400	5499	Lubrication Systems
15	5500	5599	Hydraulic Systems
16	5600	5799	Water Systems
17	5800	5999	Miscellaneous Systems
18	6000	6999	Contract Spares
20	8000	8999	Conduit and Cable Schedules
21	9000	9999	Construction GAs and Details

FIGURE E – BLOCK PROCEDURE

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011728

Electrical Symbols

All electrical symbols are to be standardized through one designated person and implemented into the system.

Blocks

Any blocks made by an operator are to carry the operator's initials and a 4-digit number, i.e. ABC1234

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011729

2. LAYER COLOR AND STRUCTURE

Layering Structure				
Layer Name	**Layer Color**	**ACAD Line Weight (LATER)**	**Description**	**M-Manufacturing Eng. E- Electrical**
0	White			E & M
BMText	Yellow		Bill of Material Text and Leaders	E & M
Border	Red		Title Block Outline	E & M
Bordertext	White		Title Text Information	E & M
Dimensions	Yellow		Dimensions	M
Dimensions 1	Yellow		Specific Dimensions	M
Equipment	Cyan		Equipment Outlines (i.e. Items on SubPanels)	M
General	Green		General Wiring for Drawings	E
Hidden	Cyan		Hidden Lines	M
Hole	Red		Drilling Pattern Holes	M
Labels	Green		ID Labels - Text on Label to be Yellow	M
Misc	Cyan		Customer Required Information	E & M
Ord-Dimensions	Yellow		Ordinate Dimensions	M
Outlines	Cyan		Panel Outlines including Sub Panels	M
Part Numbers	Yellow		Part Numbering	M
Text	Yellow		All Text and Associated Leaders	E & M
WireCodes	Magenta		Wire Codes for Drive Schematics	E
Wireways	White		Wireways and Wireway Hatch Pattern	M

Note: Design blocks on layer 0 and insert them on the layer that the item is to be placed on.

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

LAYER	FOUNDATIONS	ACAD LINE WEIGHT	ACAD COLOR	LAYER	PIPING	ACAD LINE WEIGHT	ACAD COLOR
1	PRIMARY LINES (New conc. Top of conc. Elevation text & leaders)	.02	1	31	PRIMARY LINES (New equip)	.03	7
2	HIDDEN LINES (New)	.02	1	32	UNDERGROUND PIPING (New)	.03	4
3	PRIMARY LINES (Exist)		2	33	PRIMARY LINES (Exist. Equip.)	.01	6
4	HIDDEN LINES (Exist.)	0	2	34	UNDERGROUND PIPING (Exist.)	.01	6
5	PRIMARY LINES (Piers & GB)	.02	3	35	ABOVEGROUND PIPING	.01	7
6	UNDERGRD LINES (Piers & GB)	.02	3	36	MISC. (Disipline related)	0	7
7	ANCHOR BOLTS	0	4	37	MISC. (Disipline related)	0	7
8	EMBEDDED STEEL	0	6	38	NON-DIMENSIONAL FLOW SHTS.	.01	3
9	TEXT (Discipline related)	0	7	39	TEXT (Discipline Related)	0	7
10	DIMENSIONING (Discipline related)	0	7	40	DIMENSIONING (Discip. Related)	0	7
	STRUCTURAL				**ELECTRICAL / INSTRUMENTATION**		
11	PRIMARY LINES (New Members) STEEL	0	2	41	PRIMARY LINES (New equip)	.015	7
12	PRIMARY LINES (New Members) STEEL	0	2	42	UNDERGROUND LINES (New emb. Conduit)	.03	7
13	PRIMARY LINES (Exist. Equip.)	0	3	43	PRIMARY LINES (Exist. Equip.) NON-DIM SCHEM CONNECT	0	2
14	HIDDEN LINES (Exist.Equip.)	0	3	44	UNDERGROUND PIPING (Exist.)	0	2
15	PRIMARY LINES (Building)	0	4	45	EXPOSED CONDUIT NON-DIM SCHEM SYMBOLS	.025	4
16	HIDDEN LINES (Building)	0	4	46	TRAY	.02	3
17	MISC. (Disipline related)		7	47	TRAY SUPPORTS	.035	4
18	MISC. (Disipline related)		7	48	EMBEDDED STUB-UPS	.015	6
19	TEXT (Disipline related)	0	7	49	TEXT (Disipline related)	0	7
20	DIMENSIONING (Disipline related)	0	7	50	DIMENSIONING (Disipline related)	0	7
	PLANNING/MACHINE DESIGN				**ARCHITECTURAL**		
21	PRIMARY LINES (New Equip.)	.015	3	51	PRIMARY LINES (New)	.02	6
22	HIDDEN LINES (New equip.)	0	3	52	HIDDEN LINES (New)	0	6
23	PRIMARY LINES (Exist. Equip.)	0	1	53	PRIMARY LINES (Exist)	0	3
24	HIDDEN LINES (Exist.Equip.)	0	1	54	HIDDEN LINES (Exist)	0	3
25	PRIMARY LINES ALTER (New Equip.)	.015	2	55	TEXT (Disipline related)	1	7
26	HIDDEN LINES ALTER (New Equip.)	0	4	56	DIMENSIONING (Disipline related)	0	7
27	PRIMARY LINES ALTER (Exist Equip.)	0	7		**MISCELLANEOUS**		
28	HIDDEN LINES ALTER (Exist Equip.)	0	7	57	OPEN MISC. (Elec. Grounding)	0	4
29	TEXT (Disipline related)	0	7	58	DIMENSIONING - GENERAL (COL'S, ROWS, CL, EQUIP.)	0	7

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011731

30	DIMENSIONING (Discipline related)	0	7	59	SPARE - DO NOT USE	-	-
				60	SPARE - DO NOT USE	-	-
				61	CAD FUNCTIONS (Plotting)	-	-
				62	CAD FUNCTIONS (Plotting)	-	-
				63	BORDERS, BORDER SPECIFIC TEXT - MATCH LINES, NORTH ARROW, KEY PLANS ETC	-	7

3. TEXT PARAMETERS

3.1 STANDARD TEXT PARAMETERS

SET TEXT PARAMETERS USING THE "STYLE" COMMAND AS FOLLOWS:

TEXT STYLE NAME: ROMANS
HEIGHT: 0.00
WIDTH FACTOR: 1.0
OBLIQUING ANGLE: 0
BACKWARDS? N
UP-SIDE DOWN? N

3.2 GENERAL DRAWING TEXT

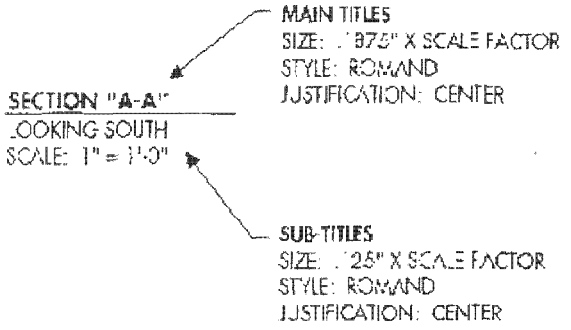
SIZE: .125 X SCALE FACTOR
STYLE: ROMANS
JUSTIFICATION: LEFT

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011732

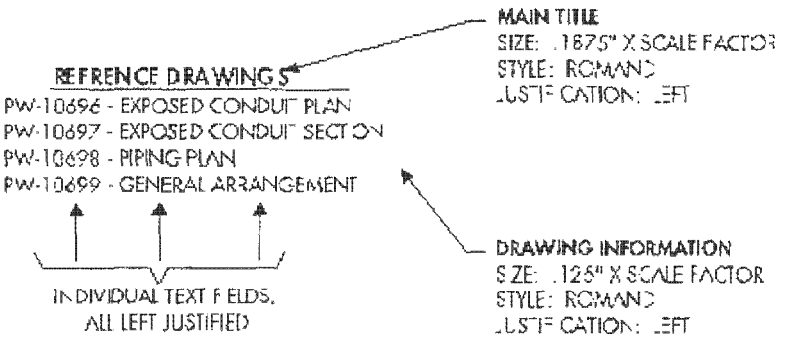
3.3 TITLES - PLAN, SECTION, DETAIL, VIEW, ETC.

EXAMPLE:



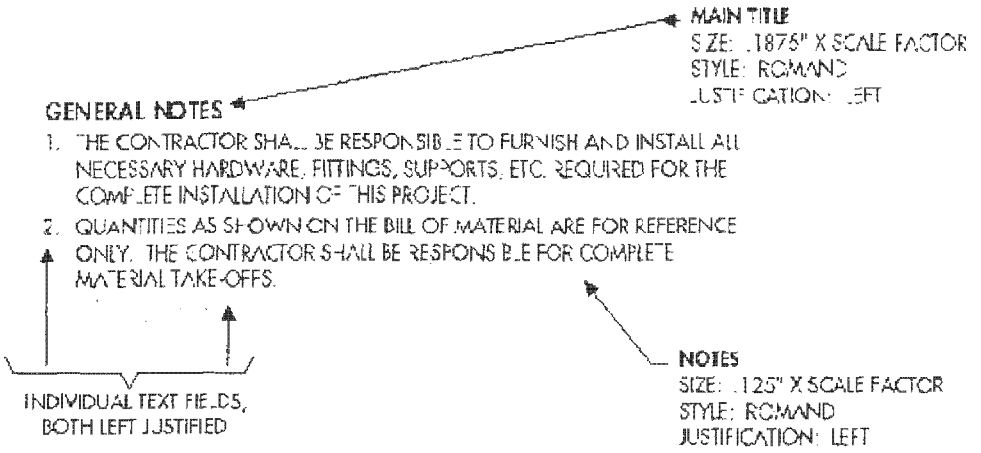
3.4 REFERENCE DRAWING LIST FORMAT

EXAMPLE:



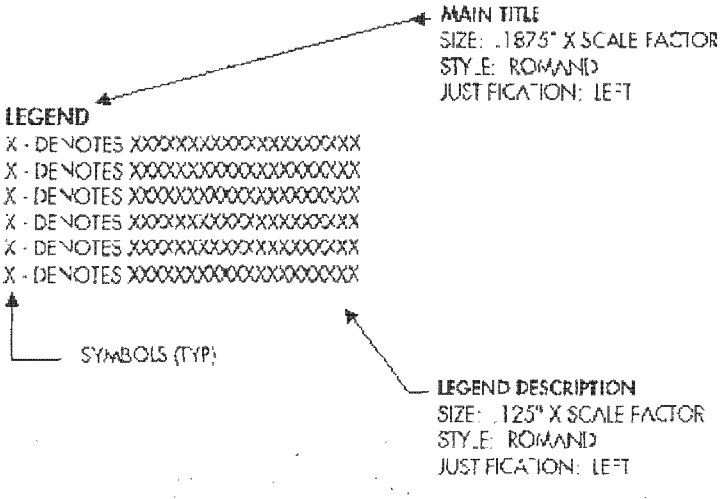
3.5 GENERAL NOTE FORMAT

EXAMPLE:



3.6 LEGEND FORMAT

EXAMPLE:

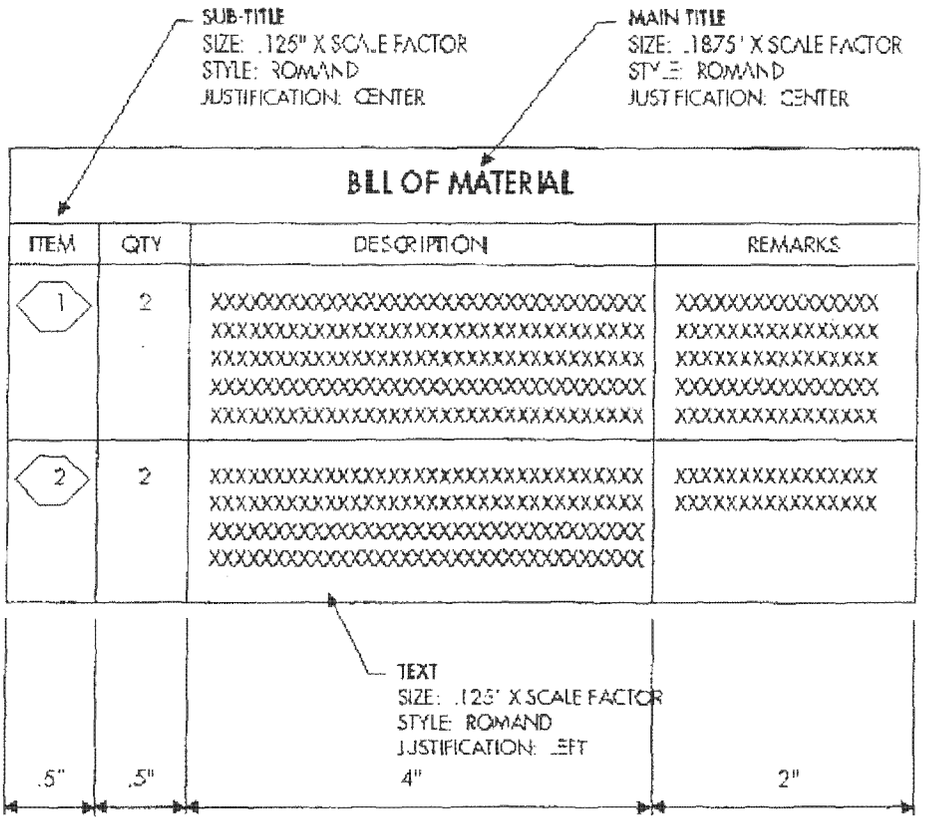


ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011734

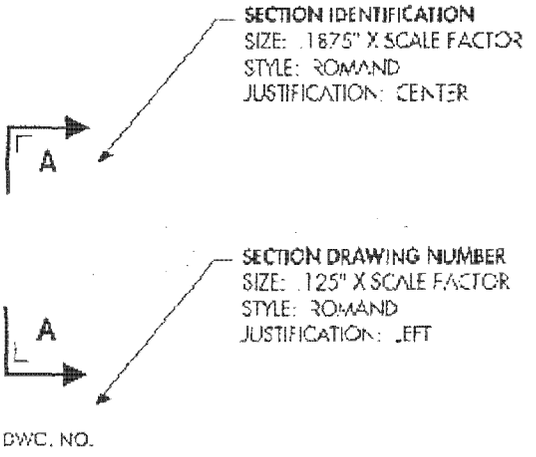
3.7 BILL OF MATERIAL FORMAT

EXAMPLE:



3.8 SECTION MARK IDENTIFICATION

EXAMPLE:



ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011735

4. STANDARD DRAWING BLOCKS:

Menu Drawing
Schematic Symbols 1
Schematic Symbols 2
Schematic Symbols 3
Schematic Symbols 4
Single-Line Symbols 1
Single-Line Symbols 2
HV Single-Line
Exposed Symbols

5. STANDARD TITLES:

8½" x 11" Proposal Title
8½" x 11" AEG Style Title
24" x 36" Proposal Title
24" x 36" Standard Title

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011736

6. CONVERSION REFERENCE TABLES:

Text Height, Dim Scale and LT Scale Chart
Autocad Drawing Scales (English)
Metric Drawing Scales
Drawing Scale - English to Metric Comparisons
Scale Factor for Drawings with Mixed Scales
Scale Factor for Drawings with Mixed Scales
Decimals of a Foot
Decimal Equivalents of Parts of an Inch in Millimeters

Drawing Scale	Text Height	Scale Factor DIM Scale	LT Scale	Drawing Size
1" = 1" 12" = 1'	0.125	1	0.375	2'-10 1/2" x 1'-11 1/2"
6" = 1'	0.2	2	0.75	5'-9" x 3'-11"
3" = 1'	0.4	4	1.5	11'-6" x 7'-10"
1 1/2" = 1'	0.8	8	3	23' x 15'-8"
1" = 1'	1.2	12	4.5	34'-6" x 23'
3/4' = 1'	1.6	16	6	46' x 31'-4"
1/2" = 1'	2.4	24	9	69' x 47'
3/8" = 1'	3.2	32	12	92' x 62'-8"
1/4" = 1'	4.8	48	18	138' x94'
3/16" = 1'	6.4	64	24	184' x 125'-4"
1/8" = 1'	9.6	96	36	276' x 188'
1" = 10'	12	120	45	345' x 235'
3/32" = 1'	12.8	128	48	368' x 250'-8"
1/16" = 1'	19.2	192	72	552' x 376'
1" = 20'	24	240	90	690' x 470'
1" = 30'	36	360	135	1035' x 750"
1" = 40'	48	480	180	1380' x 940'
1" = 50'	60	600	225	1725' x 1175'
1" = 60'	72	720	270	2070' x 1410'
1" = 70'	84	840	315	2415' x 1645'
1" = 80'	96	960	360	2760' x 1880'
1" = 90'	108	1080	405	3105' x 2115'
1" = 100'	120	1200	450	3450' x 2350'

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011737

AUTOCAD DRAWING SCALES (ENGLISH)

1. FOR DETERMINING SCALE FACTORS, USE THE FOLLOWING:

   ENGINEERING SCALE
   SCALE RATIO x 12 = SCALE FACTOR
   EXAMPLE SCALE = 1:80
   80 x 12 = 960
   ARCHITECTURE SCALE
   12 ÷ (DECIMAL EQUIVALENT OR SCALE) = S.F.
   EXAMPLE SCALE = 1/4" = 1'-0"
   12 ÷ .25 = 48

2. FOR DETERMINING LTSCALE AND TEXT SIZES, USE THE FOLLOWING:

   TEXT
   SCALE FACTOR x TEXT SIZE = SCALED TEXT SIZE
   48 x .1 = 4.8"
   LTSCALE
   SCALE FACTOR x .375 = EQUIVALENT LTSCALE

METRIC DRAWING SCALES

1. FOR DETERMINING SCALE FACTORS, USE THE FOLLOWING:

   ENGINEERING SCALE
   SCALE RATIO x 12 = SCALE FACTOR
   EXAMPLE SCALE = 1:80
   80 x 12 = 960

   ARCHITECTURE SCALE
   12 ÷ (DECIMAL EQUIVALENT OR SCALE) = S.F.
   EXAMPLE SCALE = 1/4" = 1'-0"
   12 ÷ .25 = 48

2. FOR DETERMINING LTSCALE AND TEXT SIZES, USE THE FOLLOWING:

   TEXT
   SCALE FACTOR x TEXT SIZE = SCALED TEXT SIZE
   48 x .1 = 4.8"

   LTSCALE
   SCALE FACTOR x .375 = EQUIVALENT LTSCALE

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011738

		FULL SIZE	( ) = 1'-0"										
			1/16	3/32	1/8	3/16	1/4	3/8	1/2	3/4	1	1 1/2	3
SCALE FACTOR PLOT SCALE [1 = (X)] DIMSCALE		1	192	128	96	64	48	32	24	16	12	8	4
LTSCALE		.375	72	48	36	24	18	12	9	6	4.5	3	1.5
TEXT SIZES	7/64	.1	19.2	12.8	9.6	6.4	4.8	3.2	2.4	1.6	1.2	.8	.4
	1/8	.125	24	16	12	8	6	4	3	2	1.5	1	0.5
	5/32	.15625	30	20	15	10	7.5	5	3.75	2.5	1.875	1.25	.625
	3/16	.1875	36	24	18	12	9	6	4.5	3	2.25	1.5	.75
	1/4	.25	48	32	24	16	12	8	6	4	3	2	1

		1" = ( ) FT.						( ) x FULL			( ) = 1"			
		10	20	30	40	50	60	2x	3x	4x	1/16	1/8	1/4	1/2
SCALE FACTOR PLOT SCALE [1 = (X)] DIMSCALE		120	240	360	480	600	720	.5	.3333	.25	16	8	4	2
LTSCALE		45	90	135	180	225	270	.1875	.125	.0938	6	3	1.5	.75
TEXT SIZES	7/64	12	24	36	48	60	72	.05	.0333	.025	1.6	.8	.4	.2
	1/8	15	30	45	60	75	90	.0625	.0417	.0313	2	1	.5	.25
	5/32	18.75	37.5	56.25	75	93.75	112.5	.078125	.05208	.03906	2.5	1.25	.625	.3125
	3/16	22.5	45	67.5	90	112.5	135	.09375	.0625	.0469	3	1.5	.75	.375
	1/4	30	60	90	120	150	180	.125	.0833	.0625	4	2	1	.5

PLOT FULL SIZE (I) 1 = DIMSCALE
PLOT FULL SIZE (M) 1 : SCALE

7. DIMENSION VARIABLES AND SETTINGS

Autocad Dimension Setting Chart

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011739

Autocad Dim Variables Aid
Autocad Dim Variables Aid
Autocad Dim Variables Aid

NAME	DESCRIPTION	TYPE	SETTINGS
DIMALT	Alternate Units	Switch	Off
DIMALTD	Alternate Units Decimal Places	Integer	2
DIMALTF	Alternate Units Scale Factor	Scale	25.4
DIMAPOST	Alternate Units Text Suffix	String	None
DIMASO	Associative Dimensioning	Switch	On
DIMASZ	Arrow Size	Distance	.1
DIMBLK	Arrow Block	String	None
DIMBLK1	Separate Arrow Block 1	String	None
DIMBLK2	Separate Arrow Block 2	String	None
DIMCEN	Center Mark Size	Distance	0.09
DIMCLRE	Extension Line Color	Color number	Byblock
DIMCLRT	Dimension Text Color	Color number	Byblock
DIMCRD	Dimension Line Color	Color number	Byblock
DIMDLE	Dimension Line Extension	Distance	0.0
DIMDLI	Dimension Line Increment	Distance	0.38
DIMEXE	Extension Line Extension	Distance	.0625
DIMEXO	Extension Line Offset	Distance	0.0625
DIMFAC	Length Factor	Scale	1.0
DIMGAP	Dimension Line Gap	Distance	0
DIMLIM	Limits Dimensioning	Switch	Off
DIMPOST	Dimension Text Suffix	String	None
DIMRND	Rounding Value	Scaled distance	0.0
DIMSAH	Separate Arrow Blocks	Switch	Off
DIMSCALE	Dimension Feature Scale Factor	Scale	See Note
DIMSE1	Suppress Extension Line 1	Switch	Off
DIMSE2	Suppress Extension Line 2	Switch	Off
DIMSHO	Show Dragged Dimension	Switch	On
DIMSOXD	Suppress Outside Dimension Lines	Switch	Off
DIMSTYLE	Dimension Style	Name	Unnamed
DIMTAD	Text above Dimension Line	Switch	On
DIMTFAC	Tolerance Text Scale Factor	Scale	1.0
DIMTIH	Text Inside Horizontal	Switch	Off
DIMTIX	Text Inside Extension Lines	Switch	Off
DIMTM	Minus Tolerance Value	Scaled distance	0.0
DIMTOFL	Text Outside, Force Line Inside	Switch	Off
DIMTOH	Text Outside Horizontal	Switch	Off
DIMTOL	Tolerance Dimensioning	Switch	Off
DIMTP	Plus Tolerance Value	Scaled distance	0.0
DIMTSZ	Tick Size	Distance	0.0
DIMTVP	Text Vertical Position	Scale	0.0
DIMTXT	Text Size	Distance	.1
DIMZIN	Zero Suppression	Integer	3

NOTE: FOR DIMSCALE SETTINGS, SEE SCALE FACTOR ON AUTOCAD DRAWING SCALES CHART (ENGLISH AND METRIC) VOLUME 1, SECTION 8, PAGES 2 AND 3.

8. VENDOR DRAWING SPECIFICATIONS

All incoming vendor drawings should be accompanied by a transmittal number.

ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011740

If electronic files are sent:

1. Drawings need to be set at limits.
2. Blocks should not be exploded.
3. Borders should not be exploded.
4. One drawing, one sheet per file (no multiple sheets inside one file).
5. Drawings must be in AUTOCAD format (.DWG/.DXF).
6. All drawings features should be on specific layers as per CAD Standards (EW40502).
7. No extraneous nonsense outside of the drawings.
8. All drawings should be purged prior to saving.
9. Drawings should reference the ALSTOM project number on the face of the drawing.

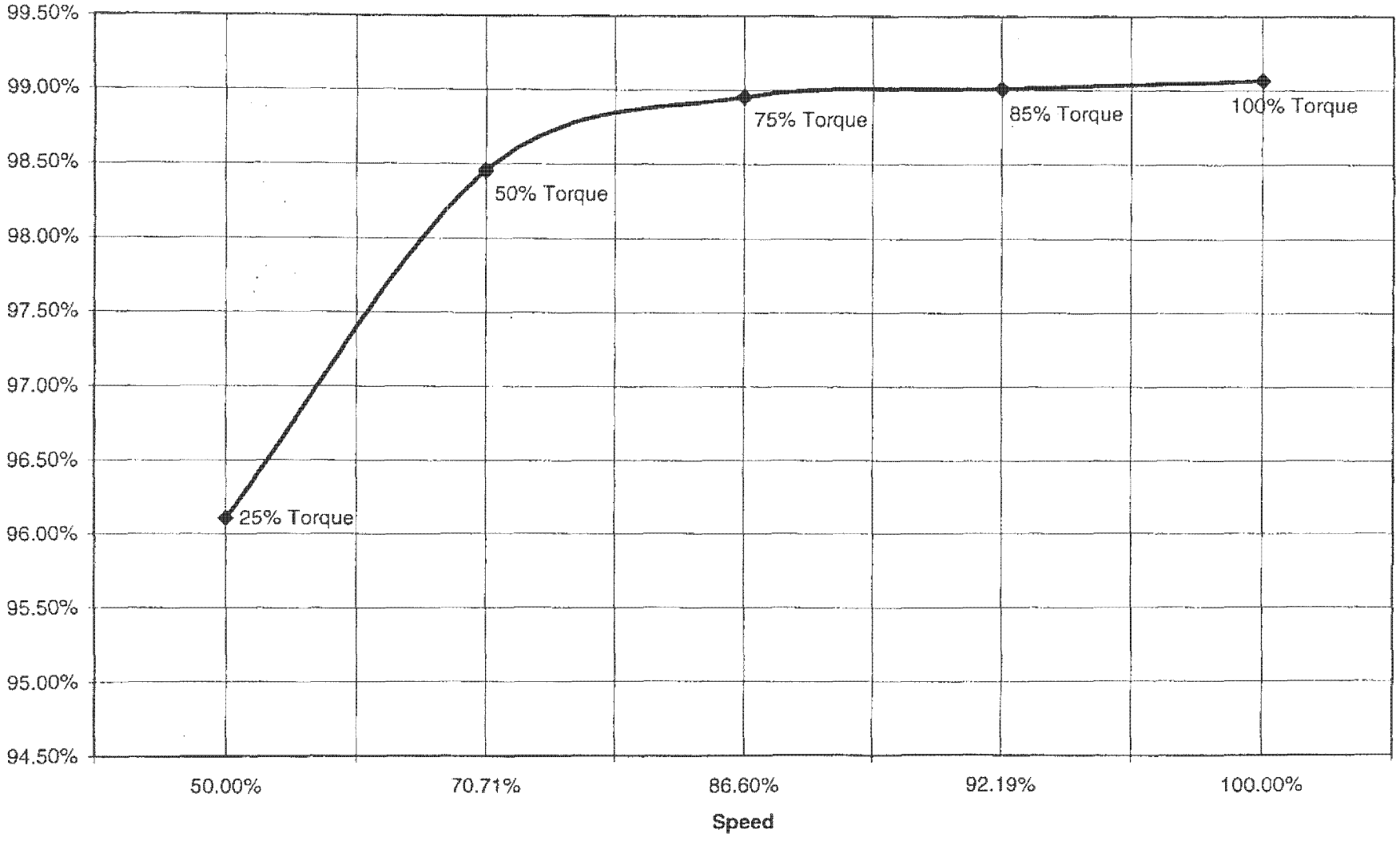
ALSTOM Drives & Controls
610 Epsilon Drive
Pittsburgh PA 15238

IP7011741

ATTACHMENT 4

DRIVE EFFICIENCY VERSUS SPEED

Drive Efficiency versus Speed



IP7011744

0:/13/:4 12:48 CFGE ADWP → 435 864 6678 IPSC PURCHASING NO.002 D01 003

INTERMOUNTAIN POWER SERVICE CORPORATION

REQUISITION FOR CAPITAL EQUIPMENT

☐ PURCHASE AUTHORIZATION FOR EXPENSE ITEMS

Purpose of Materials, Supplies or Services:

Replace existing ID Fan Drives

Date:	July 2, 2003
Req./PA No:	190821
P.O. No:	OH - 45605
Vendor:	8137 Alstom
Terms:	61
FOB:	5
Ship Via:	8
Conf. To:	S. Klein

Due: 12/31/07
Buyer - (8)

Suggested Vendor: see bid list

Account No. 1CCX-0402
Work Order No. 02-53663-00
Project No. IGS02-07

Qty	Unit	Noun / Description / Adjective	Catalog #	Seller or Manufacturer	Unit Cost	Extension
1	~~Each~~	Variable frequency drive system, induced draft			~~$950,000.00~~	$7,600,000.00
		fan per ~~the attached~~ specification # 45605				$4,153,770.-
		and Alstom proposal dated 8/21/2003				
						4153,770.00
		TOTAL ESTIMATED COST				$7,600,000.00

RECEIVED
JUL 3 1 2003
PURCHASING

Remarks: Multi- year project with one drive system purchased in 2003-2004, two drive systems purchased in 2004-2005, three drive systems in 2005-2006 and two drive systems in 2006-2007.

Delivery requested by [Date] 01-31-04 Originator Jon P. Christensen

Dept. Mgr/Supt. Date — Station Manager 7/29/03 Date — Operating Agent 8-25-03 Date

PURCHASE ORDER

INTERMOUNTAIN POWER SERVICE CORP.
Delta, Utah 84624-9546 (435) 864-4414 - Purchasing FAX (435) 864-6678

09 JAN 2004
REVISED 18 DEC 2007

VENDOR MUST SHOW P.O. NUMBER ON ALL INVOICES, BILL OF LADING, CORRESPONDENCE, AND ON PACKING LISTS IN EACH CONTAINER, TO INSURE PROMPT PAYMENT. CHARGES FOR TRANSPORTATION MUST BE SUPPORTED BY COPY OF FREIGHT BILL.

PURCHASE ORDER NO.	VENDOR CODE	REQUISITION NO
04-45605	8137	

IP7011745

VENDOR: ALSTOM POWER CONVERSION (8743)
GENERAL DRIVES
610 EPSILON DRIVE
PITTSBURGH, PA 15238-2880
412-967-0765 OR 604-948-2585

* * * S H I P T O * * *
INTERMOUNTAIN POWER SERVICE CORPORATION
850 W. BRUSH WELLMAN RD.
DELTA , UT 84624-9546

CONFIRMING DO NOT DUPLICATE	NON CONFIRMING	SHIP VIA	TERMS	FOB POINT	PAGE OF	
X		BEST WAY	AS INVOICED	S/P P.P. & ADD	1 OF 1	MAIL

INTERMOUNTAIN POWER SERVICE CORPORATION'S STANDARD TERMS AND CONDITIONS ARE INCLUDED AS PART OF THIS AGREEMENT

QUANTITY ORDERED	U M	IPSC PART NO.	DESCRIPTION	ACCOUNT NUMBER	UNIT PRICE	EXTENSION
			THIS IS A PURCHASE ORDER ADJUSTMENT **PER JON CHRISTENSEN, EXTEND CONTRACT DATE TO 06/30/08** JRL/CLE 12/18/07			

1. Invoices and correspondence may be mailed to Intermountain Power Service Corporation, 850 West Brush Wellman Rd., Delta, Utah, 84624-9546.
2. Acknowledgement is required if shipment will not be made within FIVE days.
3. **Mark packages or items with IPSC part number and/or P.O. Line number. Show number on invoice and packing slip.**
4. Vendor must furnish applicable material safety data sheets.
5. Add to invoice all applicable federal taxes.

UTAH VENDORS ARE TO ADD TO THE INVOICE ALL APPLICABLE STATE, AND COUNTY TAXES.

OUT OF STATE VENDORS, LICENSED TO COLLECT UTAH TAXES. ARE TO ADD TAX OF 6%.

UTAH TAXES WILL BE ACCRUED BY IPSC FOR OUT OF STATE VENDORS NOT LICENSED TO COLLECT UTAH STATE TAX

JOHN LARSEN 435-864-4414

REVIEWED BY GEORGE CROSS BUYER

PURCHASE ORDER

INTERMOUNTAIN POWER SERVICE CORP.
Delta, Utah 84624-9546 (435) 864-4414 - Purchasing FAX (435) 864-6678

09 JAN 2004

VENDOR MUST SHOW P.O. NUMBER ON ALL INVOICES, BILL OF LADING, CORRESPONDENCE, AND ON PACKING LISTS IN EACH CONTAINER, TO INSURE PROMPT PAYMENT. CHARGES FOR TRANSPORTATION MUST BE SUPPORTED BY COPY OF FREIGHT BILL.

PURCHASE ORDER NO.	VENDOR CODE	REQUISITION NO
04-45605	8137	190821

IP7011746

VENDOR: ALSTOM POWER CONVERSION INC
GENERAL DRIVES
610 EPSILON DRIVE
PITTSBURGH, PA 15238-2880
412-967-6912 OR 604-948-2585

* * * S H I P T O * * *
INTERMOUNTAIN POWER SERVICE CORPORATION
850 W. BRUSH WELLMAN RD.
DELTA , UT 84624-9546

CONFIRMING DO NOT DUPLICATE	NON CONFIRMING	SHIP VIA	TERMS	FOB POINT	PAGE OF	
X		BEST WAY	AS INVOICED	S/P P.P. & ADD	1 OF 1	NONE

INTERMOUNTAIN POWER SERVICE CORPORATION'S STANDARD TERMS AND CONDITIONS ARE INCLUDED AS PART OF THIS AGREEMENT

QUANTITY ORDERED	U M	IPSC PART NO.	DESCRIPTION	ACCOUNT NUMBER	UNIT PRICE	EXTENSION
1	LT		LINE 1 DRIVE SYSTEMS, VARIABLE FREQUENCY, INDUCED DRAFT FAN **PER SPECIFICATIONS 45605 & ALSTOM'S PROPOSAL DATED 08/21/03**	1CCX-402	4,153,770.00	4,153,770.00
			CONFIRMING TO S. KLEIN - DO NOT DUPLICATE JRL/LF **NOTE: THIS PURCHASE ORDER WAS CREATED FOR ACCOUNTING AND TRACKING PURPOSES ONLY** ** THIS IS A CONFIRMING PURCHASE ORDER DUPLICATE ITEMS WILL BE RETURNED AT YOUR EXPENSE **			
			DATE REQUIRED 12/31/07		TOTAL COST	4,153,770.00

1. Invoices and correspondence may be mailed to Intermountain Power Service Corporation, 850 West Brush Wellman Rd., Delta, Utah, 84624-9546.
2. Acknowledgement is required if shipment will not be made within FIVE days.
3. **Mark packages or items with IPSC part number and/or P.O. Line number. Show number on invoice and packing slip.**
4. Vendor must furnish applicable material safety data sheets.
5. Add to invoice all applicable federal taxes.

UTAH VENDORS ARE TO ADD TO THE INVOICE ALL APPLICABLE STATE, AND COUNTY TAXES.

OUT OF STATE VENDORS, LICENSED TO COLLECT UTAH TAXES. ARE TO ADD TAX OF 6%.

UTAH TAXES WILL BE ACCRUED BY IPSC FOR OUT OF STATE VENDORS NOT LICENSED TO COLLECT UTAH STATE TAX

JOHN LARSEN 435-864-4414

BUYER

REVIEWED BY GEORGE CROSS